Dr. Ambedkar Institute of Technology

Department of Electrical and Electronics Engineering

The NAAC documents enclosed are verified and approved.

Jayaramu G
5/11/22

HOD

Dept. of EEE

HOD
Department of Electrical and Electronics Engg.
Dr. Ambedkar Institute of Technology
Bengaluru-560056

Panchajanya Vidya Peetha Welfare Trust (Regd)

Dr. Ambedkar Institute of Technology

Aided by Govt. of Karnataka, An Autonomous Institution, Affiliated to Visvesvaraya Technological University, Belagavi, Approved by All India Council for Technical Education (AICTE), New Delhi, Accredited by NBA and NAAC with 'A' Grade

BDA Outer Ring Road, Mallathahalli, Bengaluru - 560 056

Ref. No. ....   Date : 05-01-2023

2021-22

Subjects focusing on Employability/Entrepreneurship/Skill development for the year

S.No	Subject Code	Subject
1.	18EE31	Analog Electronic Circuits
2.	18EE32	Logic Design
3.	18EE33	Network Analysis
4.	18EE34	Transformer and Induction Machines
5.	18EE35	Generation, Transmission & Distribution
6.	18EEL36	Electronic Circuits Lab
7.	18EEL37	Logic Design Lab
8.	18EE41	Electrical & Electronic Measurements and Instruments
9.	18EE42	Control Systems
10.	18EE43	DC Machines and Synchronous Machines
11.	18EE 44	Power Electronics
12.	18EE 45	Linear Integrated Circuits & Applications
13.	18EE L46	Transformer and Induction Machines Lab
14.	18EE L47	Power Electronics Lab
15.	18EE51	Signals and Systems
16.	18EE52	Field Theory
17.	18EE53	Microcontroller
18.	18EE54	Electrical Machine Design
19.	18EEL56	Control Systems Lab
20.	18EEL57	DC Machines and Synchronous Lab
21.	18EE551	Programmable Logic Controllers
22.	18EE552	VLSI Circuits & Design
23.	18EE553	Modern Control Theory
24.	18EE554	Embedded Systems
25.	18EE61	Power System Analysis-I
26.	18EE62	High Voltage Engineering
27.	18EE63	Digital Signal Processing
28.	18EEL65	Digital Signal Processing Lab
29.	18EEL66	Micro controller Lab

30.	18EE642	Special Electrical Machines
31.	18EE643	Artificial Intelligence to Electrical Engineering
32.	18EE644	Electrical Vehicle Technology
33.	18EE645	Smart Grid Technology
34.	18EE646	OOPS with C++
35.	18EE71	Power System Analysis-2
36.	18EE72	Modern Power System Protection
37.	18EEL76	Power System Simulation Lab
38.	18EEL77	Relay & High Voltage Lab
39.	18EEL78	Computer Aided Electrical Drawing
40.	18EE731	Sensors and Transducers
41.	18EE732	Insulation Engineering
42.	18EE733	Flexible AC Transmission Systems (FACTS)
43.	18 EE741	Power System Operation & Control
44.	18 EE742	Computer Control of Electrical Drives
45.	18 EE743	Energy Auditing & Demand Side Management

Jayaraman

BOS Chairman

Principal

Subject Title : Analog Electronic Circuits

Sub.Code: 18EE31 No. of Credits:04=04:0:0 (L - T – P) No. of Lecture Hours/Week: 04
Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:52

Course Learning Objectives:

1. To study the basic concepts of diode circuits such as clippers, clampers and rectifiers
2. To analyze and design of different transistor circuit biasing along with bias stabilization.
3. To study the modelling of transistor and frequency response.
4. To study and to analyze general, feedback and power amplifiers.
5. To study the basics concept of oscillators and FET amplifiers along with characteristics.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Diode Circuits:** Diode resistance, diode equivalent circuits, transition and diffusion capacitances, clippers and clampers, rectifiers. TEXT 1 and TEXT 2. Reference Book 1 to 5	10	L1,L2,L3.
2	**Transistor Biasing**: Operating point, analysis and design of fixed bias circuits, emitter stabilized biased circuits, voltage divider bias, and collector voltage feedback bias. Transistor switching circuits. Bias stabilization: stability factor of different biasing circuits. TEXT 1 and TEXT 2. Reference Book 1 to 5	10	L1,L2,L3.
3	**Transistor Modelling and Frequency Response:** Transistor as two port network, low frequency hybrid model., relation between h– parameter model of CE, CC and CB modes, Millers theorem and its dual. General frequency considerations, low frequency response, miller effect capacitance, high frequency response. TEXT 1 and TEXT 2. Reference Book 1 to 5	10	L1 to L4
4	**a) Multistage Amplifiers:** Cascade and cascade connections, Darlington circuits, analysis and design. **b) Feedback Amplifiers:** Feedback concept, different type of feedback circuits- block diagram approach, analysis of feedback circuits. **c) Power Amplifiers**: Amplifier types, analysis and design of Class A & Class B amplifiers, Harmonic distortion TEXT 1 and TEXT 2. Reference Book 1 to 5	11	L1 to L4
5	**a) Oscillators:** Principle of operation, analysis of phase shift oscillator, Wien bridge oscillator, RF and crystal oscillator. (BJT versions) **b) Field Effect Transistors:** Construction, working and characteristics of JFET and MOSFET. Biasing of JFET. Analysis	11	L1 to L4

	and design of JFET (only common source configuration with fixed bias) TEXT 1 and TEXT 2. Reference Book 1 to 5		

Note 1: Unit 1 to 5 will have internal choice

Note2:
a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 1 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes:

CO1 Recall the basic diode circuits and describe various wave shaping circuits.

CO2 Explain the working of transistor biasing circuits and locate quiescent point.

CO3 Analyze the models of transistor & FET amplifier circuits.

CO4 Design and develop various transistor amplifier circuits.

CO5 Construct and solve the transistor oscillator circuits.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2**	**10**	**3**	**3**	**1**	**3**			**2**	**2**		**1**		**1**
2.	CO2	**2**	**10**	**3**	**3**	**1**	**3**			**2**	**2**		**1**		**1**
3.	CO3	**2**	**12**	**3**	**3**	**1**	**3**			**2**	**2**		**1**		**1**
4.	CO4	**4**	**12**	**3**	**3**	**1**	**3**			**2**	**2**		**1**		**1**
5.	CO5	**5**	**8**	**3**	**3**	**1**	**3**			**2**	**2**		**1**		**1**
Average CO				**3**	**3**	**1**	**3**			**2**	**2**		**1**		**1**

Course Outcomes Mapping with Programme Specific Outcomes

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	3		1
CO2	3		1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", 11th Edition, Pearson Education, 2015.
2. Millman and Halkias, "Electronic Devices and Circuits", 4th Edition, Mc Graw Hill, 2015.
3. David A Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2008.

Reference Text Books.

1. Muhammad Rashid, "Microelectronics Circuits Analysis and Design", 2nd edition, Cengage Learning, 2014
2. B.L. Theraja, A.K. Theraja, "A Text Book of Electrical Technology, Electronic Devices and Circuits", edition, S. Chand Reprint, 2013
3. Anil K. Maini Vasha Agarval, "Electronic Devices and Circuits",1st edition, Wiley publisher, 2009.
4. S.Salivahanan N.Suresh, "Electronic Devices and Circuits",3rd edition, Mc Graw Hill publisher, 2013
5. Thomas L Floyd, "Fundamentals of Analog Circuits", 2nd edition, Pearson publisher, 2012.

Web Links.

1. https://www.electronics-tutorials.ws/
2. https://www.tutorialspoint.com/electronic_circuits/electronic_circuits_introduction.htm
3. https://www.electronicshub.org/tutorials/
4. https://www.allaboutcircuits.com/video-tutorials/

Subject Title : Logic Design

Sub.Code: 18EE32 No. of Credits:03=03:0:0 (L - T – P) No. of Lecture Hours/Week : 03

Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:39

Course Learning Objectives:

1. To provide a comprehensive introduction to fundamentals of digital logic design. Karnaugh Map Techniques, Quine McCluskey and MEV Techniques.
2. To provide an understanding on Karnaugh Map Techniques.
3. To provide an understanding on Quine McCluskey and MEV Techniques.
4. To design and analyze combinational circuits.
5. To design and analyze sequential circuits.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Principles of Combinational Logic-I (Karnaugh maps) - 3, 4 and 5 variables, incompletely specified functions (Don’t Care terms), Simplifying Max term equations. TEXT 1 and TEXT 2.	07	L1,L2,L3.
2	Principles of Combinational Logic-II: Limitations of K-Maps, Quine-McCluskey Tabulation Algorithm, Quine-McCluskey using don’t care terms, Map entered variables (one and two map variables). TEXT 1 and TEXT 2.	08	L1,L2,L3.
3	Analysis and design of combinational logic – II: Digital multiplexers-using multiplexers as Boolean function generators. Binary adders and subtractors, binary comparators. (1 bit, 2 bits and 4 bits) TEXT 1 and TEXT 2.	08	L1,L2,L3.
4	Sequential Circuits – I: Basic bistable element, Latches - SR latch, master-slave flip-flops (pulse-triggered flip-flops): The master-slave SR flip-flops, master-slave JK flip-flops, edge triggered flip-flops: The positive edge-triggered D flip-flops, negative-edge triggered D flip-flop TEXT 1 and TEXT 2.	08	L1,L2,L3.
5	Sequential Circuits –II: Characteristic equations, registers, counters - binary ripple counters, synchronous binary counters, counters based on shift registers (ring and Johnson), design of a synchronous counters, design of a synchronous mod-6 counter using clocked JK, D, T & SR flip-flops. Sequential Circuit Design - Mealy and Moore models. TEXT 1 and TEXT 2.	08	L1,L2,L5

Note 1: Unit 1 to 5 will have internal choice

Note2: a)Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4

b) Activity for 5 Marks has to be evaluated through PPT presentation/Subject quiz/ Project/ Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 To exemplify the concept of combinational systems using standard gates and minimization methods (Karnaugh Maps up to 5 variables)

CO2 To identify the limitations of K- map and use computerized simplification Techniques (Quine McCluskey tabulation and MEV methods).

CO3 To analyze and design combinational systems composed of standard combinational modules, such as multiplexers, decoders, encoders, adders, subtractors and binary comparators.

CO4 To demonstrate knowledge of simple synchronous sequential systems (flip-flops and latches).

CO5 To analyze and design sequential systems composed of standard sequential modules, such as counters, registers, Mealy and Moore Models.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2**	**08**	**3**	**3**	**1**	**2**						**2**		**2**
2.	CO2	**2**	**11**	**3**	**3**	**1**	**2**						**2**		**2**
3.	CO3	**2**	**12**	**3**	**3**	**1**	**2**						**2**		**2**
4.	CO4	**4**	**10**	**3**	**3**	**1**	**2**						**2**		**2**
5.	CO5	**5**	**11**	**3**	**3**	**1**	**2**						**2**		**2**
Average CO				**3**	**3**	**1**	**2**						**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	1	2	1
CO2	1	2	1
CO3	1	2	
CO4	1	2	1
CO5	1	3	
Average CO	**1**	**2**	**1**

Text Books.

1 John M Yarbrough, "Digital Logic Applications and Design", Third Reprint, Thomson, 2002

2 R D Sudhaker Samuel, "Logic Design", Revised edition, Sanguine Technical Publishers, 2006

Reference Text Books.

1 Charles H Roth, "Fundamentals of logic design", Second edition, Thomson Learning, 2004
2 Mono and Kim, "Logic and computer design Fundamentals", Second edition, Pearson, 2001

Web Links.

1 https://nptel.ac.in/courses/117/105/117105080/

Subject Title : Network Analysis

Sub.Code: 18EE33 No. of Credits:04=03:1:0 (L - T – P) No. of Lecture Hours/Week : 05
Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:65

Course Learning Objectives: This course will enable students to:

1 Describe, Apply and Analyze basic network concepts emphasizing Series and Parallel Combination of Passive Components, Source Transformation and Shifting, Star-Delta Transformation Techniques.
2. Describe, Apply and Analyze use of mesh and nodal techniques for Formulating the Transfer Function of Networks.
3 Apply and Analyze various network theorems in solving the problems related to Electrical Circuits
4 To determine the solution of electrical network using Laplace transformations, Steady state behavior of circuit elements and frequency response in resonant circuits.
5 Describe and Analyze two port networks and methods of analyzing the Electrical Networks..

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Basic Concepts: Practical sources, source transformations, network reduction using star – delta transformation, loop and node analysis with linearly dependent and independent sources for DC and AC networks. Concepts of super node and super mesh. Text 1, Text 2 and Reference Text 1	15	L1,L2,L3.
2	Network Theorems: Superposition theorem, Reciprocity theorem, Thevinin’s theorem, Norton’s theorem and Maximum Power transfer theorem. Text 1 and Text 2	14	L1,L2,L3.
3	Laplace Transformation & Applications: Solution of networks, step, ramp and impulse responses, waveform Synthesis. Text 2 and Text 3	12	L1,L2,L3.
4	a) Resonant Circuits: Series and parallel resonance, frequency-response of series and parallel circuits, Q factor, bandwidth. b) Transient behaviour and initial conditions: Behaviour of circuit elements under switching condition and their representation, Evaluation of initial and final conditions in RL, RC and RLC circuits for DC excitations. Text 2	11	L1,L2,L3.
5	a) Network Topology: Graph of a network, Concept of tree and co-tree, incidence matrix, tie-set and cut-set schedules, Formulation of equilibrium equations in matrix form, solution of resistive networks and principle of duality. Two port network parameters: Definition and Calculation of z, y, h and ABCD transmission parameters. Modeling with these parameters	13	L1,L2,L3.

	Text 2 and Text 3 and Reference 1		

Note 1: Unit 1 to 5 will have internal choice

Note2: a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4

b) Activity for 5 Marks has to be evaluated through PPT presentation/Subject quiz/ Project/ Seminar.

Note:3 Out of 5 Units, Unit 4 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes: Acquire knowledge for solving problems related to

CO1 Series and Parallel combination of Passive Components, source transformation techniques, Star – Delta Transformation techniques and source shifting techniques

CO2 Network Theorems and Electrical Laws to reduce circuit complexities and to arrive at feasible solutions.

CO3 Analyze the circuit using time and frequency domain.

CO4 Analyze and design resonant circuits.

CO5 Various Two Port Network parameters and their relationship for finding network solutions..

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10		3	1	2				2		2		2
2.	CO2	2	10	3	3	1	2				2		2		2
3.	CO3	2	12	3	3	1	2				2		2		2
4.	CO4	4	12	3	3	1	2				2		2		2
5.	CO5	5	08	3	3	1	2				2		2		2
Average Course Outcomes				**3**	**3**	**1**	**2**				**2**		**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**2**	**1**
CO2	**3**	**2**	**1**
CO3	**3**	**2**	**1**
CO4	**3**	**2**	**1**
CO5	**3**	**2**	**1**
Average PSO	**3**	**2**	**1**

Text Books.

1. Hayt, Kemmerly and Durbin, "**Engineering Circuit Analysis**", 10th Edition, TMH Publication, 2015
2. Roy Choudhury, "**Networks and systems**", 2nd Edition, New Age International Publications, 2016
3. M. E. Van Valkenburg, "**. Network Analysis**",3rd Eedition, PHI publisher, 2009

Reference Text Books.

1. A K Chakraborty, S P Ghosh, "Network Analysis and Synthesis", 1st Edition, TMH publisher, 2009
2. Robert L and Boylestad "Introductory Circuit Analysis", 4TH edition, Pearson publisher, 2010
3. M Nahvi and J A Edminister, "Electric Circuits", 2nd Edition, Schaum's Series , 2002

Web Links.

1. https://www.khanacademy.org/science/electrical-engineering/ee-circuit-analysis-topic, "
2. https://www.circuitlab.com/
3. https://www.youtube.com/watch?v=sqxzQkAdJm0

Subject Title : Transformers and Induction Machines

Sub.Code: 18EE34 No. of Credits:04=04:0:0 (L - T – P) No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:52

Course Learning Objectives:

1. To understand the concepts of transformers, induction machines and their analysis.
2. To evaluate the performance of transformers and induction machines.
3. To analyze the concepts to operate transformers in different configurations and operate in parallel.
4. To understand starters, methods of speed control of induction motor and induction generator.
5. To analyze induction motor with high torque rotors construction.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Basic Concepts: Review of principle of operation, constructional details of shell type and core type single-phase and three-phase transformers, EMF equation, losses and commercial efficiency, condition for maximum efficiency (No question shall be set from the review portion). Concept of ideal transformer, operation of practical power transformer under no load and on load -with phasor diagrams. Equivalent circuit, Open circuit and Short circuit tests, calculation of parameters of equivalent circuit and predetermination of efficiency-commercial and all-day TEXT 1 and TEXT 2. Reference Book	10	L2,L3,L4
2	Transformer continuation: Voltage regulation and its significance. Objects of testing of transformers, polarity test, Sumpner's test. Three-phase Transformers: Introduction, choice between single unit three-phase transformer and bank of single-phase transformers. Transformer connection for three phase operation – star/star, delta/delta, star/delta, delta /star and V/V. Phase conversion - Scott connection for three-phase to two-phase conversion. Current inrush in transformers. TEXT 1 and TEXT 2. Reference Book	11	L2,L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
3	Parallel operation (Single-phase & Three-phase): Need, conditions to be satisfied for parallel operation. Load sharing in case of similar and dissimilar transformers. Instrument Transformers: Current transformer and Potential transformer. (c)Three phase Induction Machines: Review of concept of rotating magnetic field. Principle of operation, construction of squirrel-cage, slip-ring induction motor (No question shall be set from the review portion). TEXT 1 and TEXT 2. Reference Book 1	11	L2,L3,L4
4	(a) Characteristic Induction Motor continuation: Slip, torque, torque-slip characteristic. Maximum torque. **p**hasor diagram of induction motor on no-load and on load. Equivalent circuit, losses, efficiency. No-load and blocked rotor tests. Circle diagram and performance evaluation of the motor. Cogging and crawling. (b) Starters & Speed Control of Three-phase Induction Motors: Need for starter. Direct on line (DOL) starters, Star-Delta and autotransformer starting. Rotor resistance starting. Soft (electronic) starters. Speed control - voltage, frequency, and rotor resistance. TEXT 1 and TEXT 2. Reference Book 1	10	L2,L3,L4
5	High torque rotors - Double Cage and deep bar rotor, Equivalent circuit and performance evaluation of double cage induction motor. Induction generator – externally excited and self-excited. Importance of induction generators. (b)Single-phase Induction Motor: Double revolving field theory and principle of operation. Types of single-phase induction motors: split-phase, capacitor start, shaded pole motors. Applications. TEXT 1 and TEXT 2. Reference Book 1	10	L2,L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note2: a)Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4

b) Activity for 5 Marks has to be evaluated through PPT presentation/Subject quiz/ Project/ Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Explain the construction, operation of transformer and induction machines (1-phase and 3-phase).

CO2 Understand the different connections for the three phase operations, advantages and applications.

CO3 Evaluate the performance of transformers and induction machines.

CO4 Analyze induction motors with different rotors and as induction generator.

CO5 Understand the different starters and speed control techniques of three-phase induction motors.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10		3	1	2				2		2		2
2.	CO2	2	10	3	3	1	2				2		2		2
3.	CO3	2	12	3	3	1	2				2		2		2
4.	CO4	4	12	3	3	1	2				2		2		2
5.	CO5	5	08	3	3	1	2				2		2		2
Average Course Outcomes				**3**	**3**	**1**	**2**				**2**		**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	3		1
CO2	3		1
CO3	3		1
CO4	3	2	1
CO5	3		1
Average CO	**3**	**2**	**1**

Text Books.

1 I. J. Nagrath and D. P. Kothari,, “Electric Machines,”, 4th Edition, Tata Mc Graw Hill, 2010

2 B L Theraja, “Electrical technology-AC & DC Machines”, 2 Vol, S Chand Publishers, 2012

Reference Text Books.

1 M. G. Say, “Performance and Design of A.C. Machines”, 3rd Edition, C.B.S Publishers, 2002

2 Kosow, “Electrical Machines and Transformers”, 2nd edition, Pearson, 2007

3 Alexander Langsdorf, “Theory of Alternating Current Machines”, 2nd edition, T.M.H, 2001

4 M.V Bhakshi, “Transformer and Induction Machine”, 3rd Edition, Technical Publisher, 2009

5 Robert M. Del Vecchi, “Transformer Design Principles”, 3rd Edition, CRC PRESS, 2017

Web Links.

1. https://www.electrical4u.com/electric-machines/
2. www.transformertechnologies.com
3. https://en.wikipedia.org/wiki/Hyperlink

Subject Title : Generation, Transmission and Distribution

Sub.Code: 18EE35	No. of Credits: 3; L:T:P- 3:0:0	No. of Lecture Hours/Week: 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 To introduce the concepts and various sources for power generation
2 To describe the overhead and underground transmission systems.
3 To understand the concepts of insulators, corona and distribution systems
4 To evaluate the line parameters of transmission systems
5 To analyze the performance of power transmission lines

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**a) Generation:** Sources of electrical power: General arrangement & working of nuclear, thermal and hydro power plant (block diagram approach only) , nuclear power plant - site selection, pros and cons, thermal power plant – site selection, pros and cons, hydro power plant, site selection, pros and cons. **b) Introduction to typical transmission and distribution systems:** General layout of power system, Standard voltages for transmission, advantages and limitation of AC transmission system. TEXT 1 and TEXT 2. Reference Book 1 & 2	07	L1,L2 & L3
2	**Overhead Transmission Lines**: Types of supporting structures and line conducting materials used. Sag calculation- supports at same level and at different levels. Effect of wind and ice, Sag at erection, Stringing chart and sag templates. Line vibration dampers. TEXT 1 and TEXT 2. Reference Book 1 & 2	08	L1,L2,L4
3	**a) Line parameters:** Calculation of inductance of single phase line, three phase line with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Capacitance of single phase line, three phase line with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. **b) Performance of Power Transmission Lines:** Short transmission lines, medium transmission lines- nominal T, End condenser and π models, long transmission lines, ABCD constants of transmission lines, Ferranti effect, line regulation. TEXT 1 and TEXT 2. Reference Book 2 & 3	08	L1,L2,L3,L4
4	**a) Insulators**: Introduction, classification, potential distribution over a string of suspension insulators. String	08	L2,L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	efficiency & methods of improving string efficiency - grading rings and arcing horns. **b) Corona:** Phenomena, disruptive and visual critical voltages, corona power loss, illustrative examples. Advantages and disadvantages of corona. TEXT 1 and TEXT 2. Reference Book 1 & 3		
5	**a) Underground Cables:** Types, material used, insulation resistance, charging current, grading of cables - capacitance grading & inter sheath grading, testing of cables. **b) Distribution systems:** Requirements of power distribution, radial & ring main systems, AC and DC distribution - Calculation for concentrated loads and uniform loading, illustrative examples. TEXT 1 and TEXT 2. Reference Book 2 & 3	8	L2,L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5 and Group Activity for 5 Marks

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Explain the different methods of Power generation concepts using renewable and non – renewable sources and typical transmission scheme and voltage levels
CO2	Describe the mechanical design calculations, different types of line insulators and the concept of Corona, formation, its influence on the operation of overhead transmission lines.
CO3	Apply the acquired knowledge of transmission and distribution systems, analyze the DC & AC distributors with different types of loads and analyse the working of underground Cables.
CO4	Apply the acquired knowledge to evaluate line parameters of 1-Φ and 3- Φ transmission and distribution systems.
CO5	Analyze the performance of power transmission lines by evaluating the line regulation and efficiency.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**1,2,3**	**10**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
2.	CO2	**1,2,4**	**10**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
3.	CO3	**1,2,3,4**	**12**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
4.	CO4	**2,3,4**	**12**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
5.	CO5	**2,3,4**	**8**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
Average COs				**3**	**3**	**1**	**2**				**2**		**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	1	1
CO2	3	1	1
CO3	3	1	1
CO4	3	1	1
CO5	3	1	1
Average CO	**3**	**1**	**1**

Text Books.

1 S. M. Singh, "Electric Power Generation, Transmission and Distribution", Second Edition, PHI Publisher, 2009

2 Soni Gupta & Bhatnagar, Dhanpat Rai & Sons, "A Course in Electrical Power", Third Edition, Dhanpat Rai & Sons Publisher, 2010

Reference Text Books.

1 W.D. Stevenson, "Elements of Power System Analysis", Fourth Edition, TMH publisher, 2017

2 Dr. S. L. Uppal, "Electrical Power Systems", Fifteenth Edition, Khanna Publications publisher, 1987

3 C. L. Wadhwa, "Electrical Power Systems", Sixth Edition, New Age International Publisher, 2010

Web Links.

1 https://nptel.ac.in/courses/108/102/108102047/

2 https://www.smartzworld.com/notes/transmission-and-distribution-pdf-vtu-td/

Subject Title : Electronic Circuits Lab

Sub.Code: 18EEL36 No. of Credits:1=0:0:1 (L - T – P) No. of Lecture Hours/Week : 02
Exam Duration:3 Hrs CIE +SEE=50+50=100 Total No.of Contact Hours:26

Course Learning Objectives:

1 To introduce the electronic components and devises to identify, read their ratings, tolerance operations etc.,
2 Design resonant circuits to resonate at required frequencies.
3 Design resonant circuits to resonate at required frequencies..
4 Design and test various amplifier circuits..
5 Construct and verify various circuits to oscillate at specified frequency

Expt No	Expertiment Contents	No.of Hours	Blooms Taxnomy level.
	Introduction: Use of bread board, CRO, power supplies, signal generators, DRBs, DIBs, DCBs; color codes, resistors, inductors, capacitors, rheostats, multimeters; transistors, diodes; device data sheets.	2	L1-L4
1	**Clipping Circuits**: Design and testing of diode shunt, series and peak detection clippers	2	L1-L4
2	**Clamping Circuits**: Design and testing of diode clamping circuits.	2	L1-L4
3	**Rectifier Circuits**: Testing of half wave, full wave and bridge diode rectifiers with and without capacitor filter, determination of ripple factor, regulation and efficiency.	2	L1-L5
4	**Resonant Circuits:** Characteristics of series and parallel resonant circuits.	2	L1-L5
5	**Transistor Static Characteristics:** CE, CB and CC modes and determination of h parameters.	2	L1-L5
6	**RC Coupled Amplifier:** Design of single stage BJT amplifier and determination of the gain-frequency response, input and output impedances.	2	L1-L5
7.	**Darlington Emitter Follower:** Design of BJT Darlington emitter follower circuit and determination of the gain, input and output impedances.	2	L1-L5
8.	**RC Phase Shift Oscillator**: Design and testing for the performance of BJT-RC Phase shift oscillator for a frequency, $f_0 \leq 10$ kHz	2	L1-L4

Expt No	Experiment Contents	No.of Hours	Blooms Taxnomy level.
9	**Tuned Oscillators:** Design and testing of the performance of BJT-RC Hartley and Colpitt's oscillator for frequency, $f_0 \geq 100$ kHz	2	L1-L5
10	**Crystal Oscillator:** Design and testing of BJT -crystal oscillator for $f_0 > 1$ MHz	2	L1-L5
	Experiments beyond the Syllabus		
1	**Cascade Amplifier:** Design of RC coupled two stage amplifier and determination of the gain-frequency response, input and output impedances.	2	L1-L5
2	**Push Pull Amplifier:** Design and testing of class B push pull power amplifier.	2	L1-L5

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcome.

CO1 Explain the working of diode wave shaping circuits and to draw transfer characteristics.

CO2 Evaluate the characteristics of BJTs

CO3 Test the resonant circuits resonating at required frequency.

CO4 Design of amplifier circuit, draw frequency response and determine input and output impedances

CO5 Construct and test transistor circuits to oscillate at desired frequencies.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2**	**2**	**3**	**3**			**1**	**1**					**2**	**2**
2.	CO2	**2**	**2**	**3**	**3**	1		**1**			**1**			**2**	**2**
3.	CO3	**2**	**3**	**3**	**3**	1		**1**		**1**				**2**	**2**
4.	CO4	**4**	**3**	**3**	**3**	1		**1**						**2**	**2**
5.	CO5	**5**	**3**	**3**	**3**	1		**1**	**1**					**2**	**2**
Average CO				3	3	1		1	1	1	1	1		2	2

Course outcomes Mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3		2	1
CO4	3		1
CO5	3	2	

Average CO	3	2	1

References Text Books.

1 Robert L. Boylestad and Louis Nashelsky, 'Electronic Devices and Circuit Theory', PHI/Pearson Education. 9TH Edition,2010

2 Departmental Laboratory Manual

Web Links.

1 http://vlabs.iitb.ac.in/vlabs-dev/labs/analog-electronics/experiments/wein-bridge-oscillator-iitr/

2 http://vlabs.iitb.ac.in/vlabs-dev/labs/analog-electronics/experimentlist.html

Subject Title : Logic Design Lab

Sub.Code: 18EEL36	No. of Credits:1=0:0:1 (L - T – P)	No. of Lecture Hours/Week : 02
Exam Duration:3 Hrs	CIE +SEE=50+50=100	Total No.of Contact Hours:26

Course Learning Objectives:

1 Introduction to digital electronics lab- nomenclature of digital ICs, specifications, study of the data sheet, concept of Vcc and ground, verification of the truth tables of logic gates using ICs.

2 Implementation of the given Boolean function using logic gates in both SOP and POS forms.

3 Verification of state tables of SR, JK, T and D flip-flops using ICs.

4 Implementation and verification of Decoder and Encoder using logic gates.

5 Design and verify the 4-bit synchronous counter.

Expt No	Experiment Contents	No.of Hours	Blooms Taxnomy level.
1	Realization of half / full Adder and half/full Subtractors using Logic gates	2	L1, L2
2	.i) Realization of parallel adder/Subtractors using 7483 chip (ii) BCD to Excess-3 code conversion and vice versa.	2	L1,L2,L3
3	Realization of Binary to Gray code converter and vice versa.	2	L1, L2, L3,L4
4	Design and Testing of 555 Timer	2	L1, L2, L3, L4
5	Realization of One / Two bit comparator & study of 7485 magnitude comparator.	2	L1, L2, L3, L4
6	MUX / DEMUX use of 74153, 74139 for arithmetic circuits and code conversion	2	L1, L2, L3, L4
7.	Design and realization of 4 bit magnitude comparator using IC 7485.	2	L1, L2, L3, L4
8.	Use of a) Decoder chip to drive LED/LCD Display and b) Priority encoder	2	L1, L2, L3, L4
9	Truth table verification of flip-flops: 1) J-K Master Slave 2) T-Type 3) D-Type	2	L1, L2, L3, L4
10	Shift left, Shift right, SIPO,SISO, PISO, PIPO operations using IC 7495S	2	L1, L2, L3, L5
	Experiments beyond the Syllabus		
1	Realization of 3 bit counters as a sequential circuit using	2	L1,l2
2	Design and Testing o Ring and Johnson counters using IC7495, IC7490, IC74193	2	L1,l2

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Apply the concept of various ICs, Logic gates and other components used in Digital logic circuit design.

CO2 Solve K-Maps and realize Boolean expressions.

CO3 Design and implement various code converters.

CO4 Design and implement combinational circuits for various digital applications.

CO5 Design and implement sequential circuits.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	**2**	**5**	**3**	**3**	**3**		**3**				**3**	**3**		**3**
2.	CO2:	**3**	**5**	**3**	**3**	**2**		**3**				**2**	**3**		**3**
3.	CO3:	**5**	**5**	**2**	**2**	**2**		**2**				**2**	**2**		**2**
4.	CO4:	**5**	**5**	**3**	**2**	**3**		**2**				**3**	**2**		**2**
5.	CO5:	**5**	**4**	**3**	**3**	**3**		**2**				**3**	**3**		**3**
Average CO				**3**	**3**	**3**		**2**				**3**	**3**		**3**

Course outcomes Mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1		2	
CO2	2	2	2
CO3		2	
CO4		2	
CO5		2	
Average CO	**2**	**2**	**2**

References Text Books.

1 K A Krishnamurthy, "Digital Lab Primer", Reprint Edition, Pearson Education Asia Publications , 2003

2 Departmental Lab Manual

Web links.

1. **State Diagram:** https://cse15-iiith.vlabs.ac.in/exp10/Introduction.html?domain=Computer%20Science&lab=DLD%20Lab
2. **ALU with function:** https://cse15-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Computer%20Science&lab=DLD%20Lab

Subject Title : Electrical and Electronic Measurements and Instruments

Sub.Code: 18EE41	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 Understand the errors encountered in measuring instruments.

2 Derive the balance conditions in AC and DC bridges for the measurement L, C, R and dissipation factor etc.

3 To analyse the working of analogue and digital measuring instruments, and determine the necessary conditions for working of instrument transformers.

4 To analyse the working principles of signal generators used in the laboratories

5 To distinguish and describe various transducers and display devices used in instrumentation.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Measurement of Power, Energy, Power factor and Frequency:** Dynamometer wattmeter construction and working principle UPF and LPF wattmeters. Measurements of real and reactive power in 3 phase circuits. Induction type energy meter construction and operation. Construction and operation of single-phase and three phase dynamometer type power factor meter. Weston frequency meter and phase sequence indicator. TEXT 1 and TEXT 2. Reference Book 1 to 3	08	L1-L4
2	**a) Measurement Errors:** Definition of error, Gross errors and systematic errors, Absolute and relative errors, Accuracy, Precision, Resolution and Significant figures. **b) Digital Instruments:** Introduction, digital voltmeters (DVM) of ramp type, successive approximation principles, resolution and sensitivity, general specifications, Digital Multimeters. ADC and DAC. Digital frequency meters. TEXT 1 and TEXT 2. Reference Book1 to 3	08	L1-L3.
3	**Bridges:** Wheatstone's bridge, Kelvin Bridge; AC bridges - Capacitance Comparison Bridge, Maxwell's bridge, Wein's bridge, Schering bridge, D'sautys bridge, Wagner's earth connection, examples. TEXT 1 and TEXT 2. Reference Book 1 to 3	07	L1-L4
4	**a) Measuring Instruments (AC and DC):** Introduction, ammeter, voltmeter, Multi-range voltmeter, extending voltmeter range. AC voltmeter using Rectifiers – Half wave and full wave, Peak responding and True RMS voltmeters, ammeters, multimeters.	08	L1-L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	b) Instrument Transformers: Construction and theory of instrument transformers, ratio and phase angle errors of C.T. and P.T. including derivation and Numerical problems. TEXT 1 and TEXT 2. Reference Book 1 to 3		
5	**a) Signal Generators and Analyzers:** Introduction, Fixed and variable AF oscillator, standard signal generator, laboratory type signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator, Sweep frequency generator. **b) Display Devices:** Digital display system, classification of display, Display devices, LEDs, LCD, Analog and Digital storage oscilloscope. TEXT 1 and TEXT 2. Reference Book 1 to 3	08	L1-L3.

Note 1: Unit 1 to 5 will have internal choice

Note2:
a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 4 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes:

CO1	Explain the working of various meters used for measurement of Power, Energy & understand the adjustments, calibration & errors in energy meters.
CO2	Understand the different measurement errors and analyse different digital instruments and their working.
CO3	Measure resistance, inductance and capacitance using bridges and determine earth resistance
CO4	Assess the performance of different measuring instruments.
CO5	Analyze and interpret different signal generator circuits for the generation of various waveforms and also to understand the use of different display devices.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**4**	**8**	**3**	**3**	**1**	**2**				**1**	**1**	**1**		**1**
2.	CO2	**3**	**8**	**3**	**3**	**1**					**1**	**1**	**1**		**1**
3.	CO3	**3**	**7**	**3**	**3**	**1**	**2**				**1**	**1**	**1**		**1**
4.	CO4	**4**	**8**	**3**	**3**	**1**	**2**				**1**	**1**	**1**		**1**
5.	CO5	**3**	**8**	**3**	**3**	**1**					**1**	**1**	**1**		**1**
Average CO				**3**	**3**	**1**	**2**				**1**	**1**	**1**		**1**

Course Outcomes Mapping with Programme Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1. A.K. Sawhney, "Electrical and electronic Measurements and Instrumentation", 10th Edition, Dhanpat Rai and Co, 2015
2. R K Rajput, "Electrical and Electronic Measurements and Instruments", 3rd edition, S Chand, 2013

Reference Text Books.

1. J. B. Gupta, "A Course in Electronics and Electrical Measurements and Instrumentation", 13th edition, Katson Books, 2008
2. David A Bell, "Electronic Instrumentation and Measurements", 2nd Edition, PHI, 2006
3. Cooper D & A D Helfrick, "Modern electronic instrumentation and measuring techniques", edition, PHI, 1998

Web Links.

1. https://lecturenotes.in/subject/64/electrical-and-electronics-measurement
2. https://www.academia.edu/8140873/A_K_Sawhney_A_course_in_Electrical_and_Electronic_Measurements_and_Instrumentation
3. https://www.pdfdrive.com/an-introduction-to-electrical-instrumentation-and-measurement-systems-a-guide-to-the-use-selection-and-limitations-of-electrical-instruments-and-measurement-systems-e158029348.html

Subject Title : CONTROL SYSTEMS

Sub.Code: 18EE42	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives: The students should be able to

1. Learn the type of System, dynamics of physical systems, classification of control system, analysis and design objective
2. Represent system by transfer function and block diagram reduction method and Mason’s gain formula
3. Learn time response analysis and demonstrate their knowledge to frequency response.
4. Learn stability analysis of system using Root locus, bode plot and Nyquist plot.
5. Learn the concept of Lag/Lead Compensator

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**a) Introduction to control system**: Types of Control Systems – Effect of Feedback Systems, Differential equation of Physical Systems – Mechanical Systems, Electrical Systems, Analogous Systems. Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs. Introduction to P, PI and PID controllers (Excluding Design). b) **Servomotor:** transfer functions, applications. TEXT 1 and Reference Book-2	10	L1,L2,L3.
2	**Time Response of feedback control systems:** Standard test signals, Unit step response of first and second order systems, Time response specifications, Time response specifications of second order systems, steady state errors and error constants. TEXT 1 and Reference Book-2	10	L1,L2,L3.
3	a) **Stability analysis:** Concepts of stability, Necessary conditions for stability, Routh- stability criterion, Relative stability analysis. b) **Root Locus Techniques:** Introduction, root locus concepts, Construction of root loci and stability studies. TEXT 1 and Reference Book-2	12	L1,L2,L3.
4	a) **Frequency domain analysis:** Introduction, Correlation between time and frequency response, bode plots, all pass and minimum phase systems, Assessment of relative stability using Bode Plots, Experimental determination of Transfer function. b) Lag and lead compensators. TEXT 1 and Reference Book-1	10	L1,L2,L3.
5	**Stability in the frequency domain:** Mathematical preliminaries, Nyquist stability criterion (Inverse polar plots	10	L1,L2,L3.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	excluded), Assessment of relative stability using Nyquist criterion (systems with transportation lag excluded). TEXT 1 and Reference Book-1		

Note 1: Unit 1 to 5 will have internal choice

Note2:

c) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

d) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 3 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes: At the end of the course students will be able to

CO1 Demonstrate an understanding of the fundamentals of control systems.

CO2 Develop the mathematical model of the physical systems.

CO3 Analyze the response of the closed and open loop systems.

CO4 Analyze the stability of the closed and open loop systems using Root locus and Bode plot techniques.

CO5 Design the various kinds of compensator

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				a	b	c	d	e	f	g	h	i	j	k	l
1.	CO1	**2**	**10**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
2.	CO2	**2**	**10**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
3.	CO3	**2**	**12**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
4.	CO4	**4**	**12**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
5.	CO5	**5**	**8**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
Average Course Outcomes				**3**	**3**	**1**	**2**				**2**		**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	1
Average CO	3	2	1

Text Books.

1 J. Nagarath and M.Gopal, "Control Systems", First Edition, Spectrum Publisher, 2008

Reference Text Books.

1 K. Ogata, ". Modern Control Engineering", 4th edition, Pearson Education Asia/PHI, 2002

2 P. S. Satyanarayana, "Concepts of Control Systems", 1st edition, Dynaram publishers, 2001

3 M. Gopal, "Control Systems – Principles and Design", 2nd edition, TMH, 1999

4 J. J. D'Azzo and C. H. Houpis, ". Feedback Control System Analysis And Synthesis", 5th edition, McGraw Hill, 2010

5 Enter name, "Book title", edition, publisher, year

Web Links.

1 http://ctms.engin.umich.edu/CTMS/index.php?aux=Home ;Control Tutorials for MATLAB and Simulink

2 https://www.youtube.com/user/ControlLectures/

Subject Title : DC MACHINES AND SYNCHRONOUS MACHINES

Sub.Code: 18EE43	No. of Credits:04=4:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1	To gain knowledge on construction and working of DC machines and synchronous machines
2	To analyze characteristics of DC machines and synchronous machines
3	To evaluate various methods of testing, losses and efficiency of DC machines.
4	To analyze various methods of determining voltage regulation of a synchronous generator.
5	To analyze the operation of a synchronous machine (both as a generator and motor).

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**DC Generator**: Classification of DC generator, types of armature winding, emf equation, no-load characteristic, armature reaction, load characteristics. Commutation, types of commutation, commutation difficulties, interpoles, compensating winding and equalizer rings (only qualitative treatment). Classification of DC motors, back emf and its significance, torque equation, characteristics of shunt, series & compound motors, speed control of shunt and series motors. Application of DC motors. TEXT 1 and TEXT 2. Reference Book. 1 & 2	10	L1,L2
2	**Losses and efficiency:** Losses in dc machines, power flow diagram, efficiency, condition for maximum efficiency. **Testing of dc machines**: Direct & indirect methods of testing of DC machines-brake test, swine burn’s test, Hopkinson’s test, retardation test, field’s test, merits and demerits of tests. TEXT 1 and TEXT 2. Reference Book. 1 & 2	10	L2,L3
3	**Synchronous machines:** Principle of operation, construction of salient & non-salient pole synchronous machines, generated emf, effect of distribution and chording of winding, harmonics-causes, reduction and elimination. Armature reaction, synchronous reactance, leakage reactance, phasor diagram of non-salient type alternator. TEXT 1 and TEXT 2. Reference Book. 2 & 3	10	L3,L4
4	**Voltage Regulation**: Voltage regulation by EMF, MMF, ZPF & ASA method. Short circuit ratio and its importance. Two reaction theory-direct and quadrature axis reactance, phasor diagram. Slip test and regulation.	12	L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	Synchronizing to infinite bus bars, parallel operation of alternators. Operating characteristics, power angle characteristics excluding armature resistance, operation for fixed input and variable excitation. TEXT 1 and TEXT 2. Reference Book: 4		
5	**Synchronous motor:** Principle of operation, phasor diagrams, torque and torque angle, effect of change in load, effect of change in excitation, 'V' and 'inverted V curves'. Synchronous condenser, hunting and damping. Methods of starting of synchronous motors. **Special DC motors**: Permanent magnet motors, brushless DC motors. Applications. TEXT 1 and TEXT 2. Reference Book 4	10	L4,L5

Note 1: Unit 1 to 5 will have internal choice

Note2:

e) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

f) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes:

CO1	Explain phenomena related to DC, synchronous machines and special machines.
CO2	Explain the operation, characteristics and performance of DC, synchronous machines and special machines.
CO3	Solve problems related to speed control, losses and efficiency of DC machines.
CO4	Analyze the behaviour of synchronous machines in parallel and on infinite bus bars.
CO5	Evaluate voltage regulation of synchronous generators by various methods.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**1**	**10**	**3**	**2**		**1**			**1**			**1**		**2**
2.	CO2	**2**	**10**	**3**	**2**		**1**			**1**			**1**		**2**
3.	CO3	**3**	**10**	**3**	**2**		**1**			**1**			**1**		**2**
4.	CO4	**4**	**12**	**3**	**2**		**1**			**1**			**1**		**2**
5.	CO5	**5**	**10**	**3**	**2**		**1**			**1**			**1**		**2**
Average CO				**3**	**2**		**1**			**1**			**1**		**2**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	1
Average CO	3	2	1

Text Books.

1 DP Kothari, I.J.Nagarath, “Electrical Machinery”, Fourth Edition, TMH, 2010

2 P.S Bhimbra, “Electrical Machines”, Seventh Edition, Khanna Publishers, year

3 AshfaqHussain, DhanpatRai, “Electrical Machines”, edition, DhanpatRai Publications, year

Reference Text Books.

1 M. G. Say, “Performance& Design of Alternating Current machines”, Third Edition , CBS publishers, 2002

2 A.E Clayton & N.N.Hancock e, “The Performance & Design of DC machines”, Third edition CBS Publication, 2004

3 Mulukuntla.S.Sarma, “Electric Machines”, First edition, Cengage Learning, 2009

4 Ahhijit Chakrabarti, SudiptaBebnath, “Electric Machines”, Electrical Machines Kindle Edition, McGraw Hill Education (India) Private Limited, year

Web Links.

1 https://nptel.ac.in/courses/108/102/108102146/

2 http://nptel.vtu.ac.in/econtent/courses/EEE/10EE54/index.php

3 https://nptel.ac.in/courses/108/105/108105017/

Subject Title : POWER ELECTRONICS

Sub.Code: 18EE44 No. of Credits:04=04:0:0 (L - T – P) No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:52

Course Learning Objectives:

1 Understand various power semiconductor devices, characteristics and their applications

2 Study different methods of triggering power semiconductor devices

3 Learn different power electronics converters with modes of operation

4 Analyze the performance of different power converter circuits for electric drives

5 Apply different methods of speed control of Electric motors

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Introduction to Power Semiconductor Devices:** Power semiconductor devices, applications. Thyristor types, SCR structure – static characteristics, switching characteristics of SCR, MOSFET and IGBT, ratings, two transistor model, di/dt and dv/dt protection. Firing circuits using UJT and digital ICs. Isolation of control & power circuit. TEXT 1 and TEXT 2. Reference Book 1	10	L1,L2,L3.
2	**Controlled Rectifiers:** Principle of phase controlled converter operation. Single-phase and three-phase converters – half, semi and full bridge converters with R & RL load. TEXT 1 and TEXT 2. Reference Book	10	L1,L2,L3.
3	**DC Choppers:** Introduction to commutation, Chopper classification, Performance parameters, control strategies, Principle of step-down and step-up chopper with R & R-L load. DC motor (Separately, Shunt & Series) Speed control, open loop and closed loop transfer function for separately excited motor -four quadrant operation of DC drive. TEXT 1 and TEXT 2. Reference Book 2	10	L1,L2,L3.
4	**a) AC Voltage Controllers:** Principle of ON-OFF and phase control with R and RL load. Single-phase bidirectional controllers with resistive and inductive loads. **b) Inverters:** Inverter classification**,** Principle of operation of basic half bridge inverter and full bridge inverter, Performance parameters. Three-phase bridge inverter-120^0 and 180^0mode of operation. TEXT 1 and TEXT 3. Reference Book1	12	L2,L3,L4
5	**Control of AC Drives:** Basic Induction Motor Equations, speed control of squirrel cage induction motor by voltage source inverter- stator voltage control, variable frequency control. Rotor resistance control and Slip power recovery scheme.	10	L1,L2,L3.

	TEXT 1 and TEXT 3.Reference Book1		

Note 1: Unit 1 to 5 will have internal choice

Note2: a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5 .

b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 4is a Webinar unit conducted through Google Classroom/ Zoom/Cisco-Webex.., and will be delivered by subject faculty.

Course Outcomes:

CO1 Identify various power semiconductor devices and study their control characteristics.

CO2 Understand the operation of analog and digital triggering circuits

CO3 Analyze different converters for power conversion system and their applications.

CO4 Apply the knowledge of different power conversion system for the control of DC drives.

CO5. Apply the knowledge of different power conversion system for the control of AC drives

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10		3	1	2	1		2	2		2		3
2.	CO2	2	10	3	3	3	2	2	2	2	2		2		3
3.	CO3	3	12	3	3	2	2	2	2	2	2		2		3
4.	CO4	3,4	12	3	3	2	2	2	2	3	2		2		3
5.	CO5	3,4	8	3	3	2	2	3	2	3	2		2		3
Average CO				3	3	2	2	2	2	3	2		2		3

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcomes	PSO1	PSO2	PSO3
CO1	1	1	
CO2	2	3	
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Average CO	3	2	3

Text Books.

1 M.H.Rashid "Power Electronics", First Edition, P.H.I. /Pearson, New Delhi, 2nd Edition, 2002

2 Ned Mohan, Tore M. Undeland, and William P. Robins, "Power Electronics - Converters, Applications and Design,", 3rd Edition, John Wiley and Sons, 2012

3 Gopal K.Dubey, "Fundamentals of Electrical Drives", 2nd edition, Tata.Mc.Hill, 2015

Reference Text Books.

1. G.K. Dubey, S.R. Doradla, A. Joshi and R.M.K. Sinha, "Thyristorised Power Controllers", 2nd edition,New Age International Publishers.,2001
2. M.D. Singh and Khanchandani K.B, "Power Electronics ",2nd edition,Narosa Publishing House, , Reprint 2015
3. J.M. Jacob Thomson, "Power Electronics, Principles and Applications",2nd edition, Vikas Publications, 2010

Web Links.

1. M B Patil,IITB,"Sequel Applications for Classroom Teaching", , https://www.ee.iitb.ac.in/ ~sequel/ sequel_app.html
2. L Umananda, "Ngspice- Power Conversion circuits," IISc, Bengaluru https://swayam.gov.in/ nd1_noc20_ee12
3. G.Bhuvaneswari,IIT Delhi. https://onlinecourses.nptel.ac.in /108/101/108101126/,
4. Prof. Vivek Agarwal, IIT, Bombay,Mumbai, "Fundamentals of Power Electronics" https://freevideolectures.com/ course/4266/ nptel-fundamental-power-electronics.

.

Subject Title : LINEAR ICS AND APPLICATIONS

Sub.Code: 18EE45 No. of Credits: 03=:2:2:0 (L - T – P) No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:52

Course Learning Objectives:

1 To understand the concepts of the basic characteristics and amp in AC amplifier circuits
2 To acquaint the students regarding frequency response and frequency compensating of op-amp..
3 To design & analyze different linear, non-linear & mathematical application circuits using op-amp
4 To understand the concepts of switched capacitor filters ,Voltage regulator and various amplifiers
5 To understand the basics of PLL and its practical applications.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**a) Introduction:** Operational amplifier description- Circuit symbol and terminals block diagram. Basic op-amp parameters - Input and output voltage range, offset voltage and current, offset nulling, CMRR, PSRR, input and output impedance**.** **b) OP-Amps as AC Amplifiers:** Capacitor-Coupled voltage follower, High Z_{in} Capacitor Coupled voltage follower, Capacitor-Coupled non-inverting amplifier, High Z_{in} Capacitor Coupled non-inverting amplifier, Capacitor-Coupled inverting amplifier, setting upper cut off frequency, use of single polarity supply. TEXT 1 and TEXT 2. Reference Book. 1 & 2	11	L1,L2,L3
2	**a) OP-Amp Frequency Response and Compensation:** Circuit stability, Frequency and phase response, Frequency compensating methods, Band width, slew rate effects, stray capacitance effects, load capacitance effects, Z_{in} mod compensation, and circuit stability precautions **b) Signal Processing Circuits:** Introduction, saturating precision half wave rectifier, non-saturating half wave precision rectifier, two output precision half wave rectifier, precision full wave rectifier using half wave rectifier and summing circuit, high input impedance full wave precision rectifier, peak clipper, dead zone circuit, precision clipper, precision clamping circuit, precision rectifier peak detector, voltage follower peak detector, sample and hold circuit. TEXT 1 and TEXT 2. Reference Book. 1 & 2	11	L2,L3
3	**a) OP-Amp Nonlinear Circuits:** Op-amps in switching circuits, zero crossing detectors, Inverting & Non inverting Schmitt trigger circuits, Astable multivibrator and monostable multivibrator.	10	L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	b) Signal Generators: Triangular wave generator, rectangular wave generator, phase shift oscillator, Wien bridge oscillator. TEXT 1 and TEXT 2. Reference Book. 1 & 2		
4	**Active Filters:** First order low pass active filter, second order low pass active filter, first order high pass active filter, second order high pass active filter, band pass filter, band stop filter. TEXT 1 and TEXT 2. Reference Book:2	10	L3,L4
5	**a) DC Voltage Regulators:** Basic linear voltage regulator, fixed output voltage regulators, adjustable output regulator(LM317/LM337), IC voltage regulators(IC723) **b) Specialized IC Applications:** Basics of universal active filter, basic phase lock loops, power amplifiers. TEXT 1 and TEXT 2. Reference Book 3	10	L2,L4,L5

Note 1: Unit 1 to 5 will have internal choice

Note2: a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5 .

c) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 5is a Webinar unit conducted through Google Classroom/ Zoom/Cisco-Webex and will be delivered by subject faculty.

Course Outcomes:

CO1 Describe the characteristics of ideal and practical operational amplifier.

CO2 Understand the behavior of op-amp linear and non- linear circuits.

CO3 Analyze the operation of op-amp in signal processing and oscillator circuits.

CO4 Analyze the operation of op-amp in filter circuits.

CO5 Design a circuit or system using integrated circuits (IC's).

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**1**	**11**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**2**	**-**	**1**
2.	CO2	**2**	**11**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**2**	**-**	**1**
3.	CO3	**3**	**10**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**2**	**-**	**1**
4.	CO4	**4**	**10**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**2**	**-**	**1**
5.	CO5	**5**	**10**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**2**	**-**	**1**
Average CO				**3**	**2**	**2**	**1**			**1**	**1**				**1**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	1	1
CO3	3	1	1
CO4	3	2	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 David A Bell, "Operational amplifiers and linear ICs", Third Edition, Oxford University Press, 2010

2 B.Somanathan Nair,, "Linear Integrated Circuits - Analysis, Design and Applications", First Edition, Wiley India,, 2009

Reference Text Books.

1 S. Salivahanan, V S KanchanaBhaaskaran, "Linear Integrated Circuits", Second Edition , McGraw Hill, 2015

2 Stanley William D, "Operational amplifiers with Linear Integrated Circuits", Fourth Edition Pearson Education, 2002

3 Ramakanth A Gayakwad, "Operational amplifiers and linear ICs", Fourth edition, PHI, 2009

Web Links.

1. https://nptel.ac.in/courses/108/108/108108111/
2. https://www.yumpu.com/en/document/view/60502162/e-book-op-amps-and-linear-integrated-circuit-technology-by-ramakant-a-gayakwad

Subject Title : Transformers and Induction Machines Lab

Sub.Code:18EEL46	No. of Credits:1=0:0:1(L - T – P)	No. of Lecture Hours/Week :02
Exam Duration:3 Hrs	CIE +SEE=50+50=100	Total No.of Contact Hours:26

Course Learning Objectives:

1. To introduce various tests on Transformer, poly-phase Induction Machines and single-phase Induction Motor and evaluation of their performance.
2. To verify the parallel operation of two dissimilar transformers load sharing.
3. To learn various methods of speed control of Induction motor.
4. To study the connection of single phase transformers for three phase operation and phase conversion.
5. To study and calculation of equivalent circuit parameter of transformer and induction machine

Expt No	Experiment contents	No.of Hours	Blooms Taxnomy level.
1	(a) Predetermination of efficiency and regulation by Open Circuit and Short circuit tests on single - phase transformer. (b) Calculation of equivalent circuit parameters from the test data and determination of efficiency, Regulation from the equivalent circuit to correlate results obtained earlier.	2	L2,L3,L4
2	Sumpner's test on similar transformers and determination of combined and individual transformer efficiency	2	L2,L3,L4
3	Parallel operation of two dissimilar (different kVA) single-phase transformers and determination of load sharing and analytical verification given the Open Circuit and Short circuit tests details.	2	L2, L3, L4
4	Connection of 3 single phase transformers star-detla, delta-star and determination of efficiency under balanced and Unbalanced resistive load	2	L2,L3, L4
5	Scott connection with balanced and unbalanced resistive loads.	2	L2,L3, L4

Expt No	Experiment contents	No.of Hours	Blooms Taxnomy level.
6	Load test on 3-phase Induction motor and determination of performance characteristics.	2	L2 L3,L4
7.	(a) NO load and Blocked rotor tests on 3-phase induction Motor Predetermination of performance from the Circle diagram. (b) Determination of parameters of the equivalent circuit of a 3-phase Induction Motor and correlate the results obtained from the circle diagram.	2	L2,L3,L4
8.	Speed control of 3-phase Induction motor by varying rotor resistance.	2	L2,L3,L4
9	Load test on- Induction generator.	2	L2,L3,L4
10	Load test on Single- Phase Induction motor.	2	L2,L3,L4
	Experiments beyond the Syllabus		
1	Polarity Test on Transformers	2	L2,L3
2	Determination of parameters of equivalent circuit of a 3-phase Induction Motor	2	L1,L2

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1	Conduct various tests on single-phase transformer, and evaluate their performance
CO2	Poly-phase induction machines and single-phase induction motor and evaluate their performance
CO3	Operate two dissimilar transformers in parallel for different load sharing.
CO4	Experiment the various methods of speed control of Induction motor.
CO5	Examine the connection of single phase transformers for three phase operation and phase conversion.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2,3,4**	**4**	3				2			2	1	1	2	
2.	CO2	**2,3,4**	**4**	3				3			1	2	1	1	
3.	CO3	**2,3,4**	**4**	3			2	2				1	1	1	
4.	CO4	**2,3,4**	**4**	3			3	2				1	1	1	
5.	CO5	**2,3,4**	**4**	3				2				1		1	
Average CO				3			3	2			2	1	1	1	

Course Outcomes Mapping with Programme Specific Outcomes

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	3		1
CO2	3		1
CO3	3		1
CO4	3		1
CO5	3		1
Average CO	**3**		**1**

References Text Books.

1 I. J. Nagrath and D. P. Kothari,, "Electric Machines", 4th Edition, Tata Mc Graw Hill, 2010

2 B L Theraja, "Electrical technology-AC & DC Machines", S Chand Publishers

3 M.V Bhakshi, "Transformer and Induction Machine", Technical Publisher

Web Links.

1 https://www.svec.education/courses/eee-course-material-lab-manuals/

2 http://rmkcet.ac.in/eee-machines-lab.php/

3 https://www.slideshare.net/KamiWijaya/2-electrical-machines-lab

4 https://www.slideshare.net/sai55chaitanya/electrical-machines-2-lab-manual/

Subject Title : Power Electronics Lab

Sub.Code:18EEL47 | No. of Credits:1=0:0:1(L-T-P) | No. of Lecture Hours/Week :02

Exam Duration:3 Hrs | CIE +SEE=50+50=100 | Total No.of Contact Hours:26

Course Learning Objectives:

1. Study the characteristics of Power semiconductor devices practically.
2. Understand controllable switches in different power electronic circuit applications.
3. Understand to generate gating signals using analog and digital modules.
4. Learn to control the speed of electrical motors using power converters
5. Analyse to control power in converters circuits with different loads

Expt No	Experiment Contents	No.of Hours	Blooms Taxnomy level.
1	Static characteristics of SCR.	2	L1, L2
2	Static characteristics of MOSFET and IGBT.	2	L1, L2
3	SCR turn-on circuit using UJT relaxation oscillator.	2	L1, L2, L3,L4
4	SCR Digital triggering circuit for single phase controlled rectifier.	2	L2, L3, L4
5	Single-phase full-wave controlled rectifier connected to *R* and *R-L* loads- with and without freewheeling diode	2	L1, L2, L3
6	A.C. voltage controller using TRIAC – DIAC/UJT combination connected to *R* load.	2	L1, L2, L3
7.	To control the Speed of a stepper motor in half step, full step mode- both in forward and reverse direction.	2	L1, L2, L3
8.	To control the Speed of a universal motor using TRI AC	2	L2, L3
9	To control the Speed of a separately excited D.C. motor using an IGBT based chopper module.	2	L1, L2, L3, L4
10	To generate PWM signal using MOSFET based single-phase full-bridge inverter and study for variation in frequency and R load.	2	L1, L2, L3, L4
	Experiments beyond the Syllabus		
1	Study the performance of SCR forced commutating circuits. — (i) By reducing the forward current below the holding current (current commutation) (ii) By applying a large reverse voltage across conducting SCR (Voltage commutation)	3	L1, L2, L3, L4

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Understand the basic operation of various power semiconductor devices experimentally.

CO2 Illustrate the basic principles of triggering circuit.

CO3 Analyse the role of power electronics in utility-related applications

CO4 Understand the operation of different power converter circuits

CO5 Justify the use of Power Electronics converters for motor control applications.

Course outcomes Mapping with Programme Outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	6		3	1	2				2	2	2	2	2
2.	CO2	2	5	3	3	1	2				2	2	2	2	2
3.	CO3	3	5	3	3	1	2				2	2	2	2	2
4.	CO4	3	5	3	3	1	2				2	2	2	2	2
5.	CO5	4	5	3	3	1	2				2	2	2	2	2
Average CO				3	3	1	2				2	2	2	2	2

Course outcomes Mapping with Programme Specific Outcomes

Course Outcomes	PSO1	PSO2	PSO3
CO1	1	1	
CO2	2	3	
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3
Average CO	3	2	3

References Text Books.

1 M.H.Rashid "Power Electronics", First Edition, P.H.I. /Pearson, New Delhi, 2nd Edition, 2002

2 G.K. Dubey, S.R. Doradla, A. Joshi and R.M.K. Sinha, "Thyristorised Power Controllers", 2nd edition, New Age International Publishers., 2001

3 Dr Jyoti Koujalagi -Lab Manual

Web Links.

1 L Umananda,IISc, Bengaluru, Ngspice- Power Conversion circuits, https://swayam.gov.in/ nd1_noc20_ee12

2 M B Patil,IITB,"Sequel Applications for Classroom Teaching", , https://www.ee.iitb.ac.in/ ~sequel/ sequel_app.html

3 G.Bhuvaneswari,IIT Delhi, www.nptel.ac.in - https://nptel.ac.in/courses/108/101/108101126/

4. Prof. Vivek Agarwal, IISc , Bengaluru, "Fundamentals of Power Electronics ", https://freevideolectures.com/ course/4266/ nptel-fundamental-power-electronics.

Note: 20% program or experiments through virtual lab or any other online platform.

Subject Title : Signals and Systems

Sub.Code: 18EE51	No. of Credits:03=02:2:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1. To learn the different types of signals and properties of Signals & Systems, convolution for LTI systems.
2. To explain the use of convolution, differential in analysing the response of LTI systems in continuous and discrete time domains and to provide a block diagram representation to it.
3. To visualize the relationship between the continuous-time, discrete-time Fourier series and Fourier transform of a signal.
4. To learn the applications of Fourier transform.
5. To explain the use of Z-transform in the complex exponential representation of discrete time signals and the analysis of systems

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Introduction: Definition of A Signal and a System, Overview of Systems, Classifications of Signals, Basic Operation On Signals, Elementary Signals, And Systems Viewed as Interconnection of Operations, Properties of Systems. TEXT 1 and TEXT 2. Reference Book	10	L1,L2,L3.
2	Time Domain Representation for LTI Systems (Continuous & Discrete): Convolution, Impulse Response Representation, Properties of Impulse Response Representation, Solution of Differential & Difference Equations, Block Diagram Representation. TEXT 1 and TEXT 2. Reference Book	10	L1,L2,L3.
3	Frequency Domain Representation of Signals and Applications: Introduction, Fourier Representation of Continuous-Time Periodic Signals, Continuous Time Fourier Transform: Representation of Non Periodic Signals, Properties of Continuous Time Fourier Transforms. Application of Fourier Representation: Frequency Response of LTI Systems. Solutions of differential equation. TEXT 1 and TEXT 2. Reference Book	11	L1,L2,L3.
4	Discrete-Time Fourier Transform: Representation of non-periodic signals. The discrete time Fourier transforms (DTFT). Properties of Discrete Time Fourier Transform. Applications: Frequency Response of LTI Systems. Solution of Difference Equations Using System Function. Sampling of Continuous Time Signals & Signal Reconstruction. TEXT 1 and TEXT 2. Reference Book	10	L1,L2,L3.
5	Z- Transforms: Introduction, Z-transform, properties of ROC, properties of Z-transforms, inversion of Z-transform methods -	11	L1,L2,L3.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	power series and partial expansion, Transforms analysis of LTI systems, transfer function, stability and causality, unilateral Z-transform and its application to solve difference equations. TEXT 1 and TEXT 2. Reference Book		

Note 1: Unit 1 to 5 will have internal choice

Note2:
a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT presentation/subject quiz/project/seminar

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Characterize and analyse the properties of CT and DT signals and systems
CO2	Analyse LTI CT and DT systems in time domain using convolution & differential equation
CO3	Represent CT and DT signals in the Frequency domain using Fourier analysis tools.
CO4	Analyse Fourier transform for differential & difference equation applications.
CO5	Use Z-transform and properties of Z transform for the analysis of discrete time systems.

Course Outcomes Mapping with Programme Outcomes.

SI.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.	CO1:	1,2,3	09	3	2	1					1		1		1
2.	CO2.	1,2,3	12	3	3	1	2				2		2		2
3.	CO3:	1,2	09	3	3	1	2				2		2		2
4.	CO4:	3,4	13	3	3	1	2				2		2		2
5.	CO5:	1,2,3	09	3	3	1					2		2		2
Average CO				3	3	1	2				2		2		2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		1
CO2	3		1
CO3	3		1
CO4	3	2	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1. Simon Haykin and Barry Vam Veen, "Signals & Systems", Reprint 2002 2nd edition , John Wiley & Sons, 2001
2. Alan V Oppenheim, Alan Willsky and S. Hamid Nawab , "Signals & Systems ", 2nd edition 1997, Pearson Education Asia , Indian Reprint 2002
3. Michael J Roberts, "Signals & Systems Analysis of signals through linear systems ", Tata McGraw Hill, 2003.
4. Nagoor Kani, "Signals and Systems ", 1st Edition 2010, Tata McGraw Hill.

Reference Text Books.

1. M J Roberts , "Signals & Systems ", Third edition , McGraw Hill, 2009
2. Dr D Ganesh Rao and Satish Tunga, "Signals & Systems ", Fourth edition , Sanguine, 2008
3. P Ramakrishna Rao and Shankar Prakriya , "Signal & Systems" Second edition Mcgraw Hill 2013

Web Links.

1. https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/lecture-notes/
2. https://www.sanfoundry.com/signals-systems-questions-answers-mcqs/

Subject Title : Field Theory

Sub.Code: 18EE52	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1. To understand the concept of Coulomb's law, Gauss' law and divergence and its applications
2. To understand the concept of energy, density, conductor and dielectrics and the boundary conditions for an electric field
3. To understand the concept of Poisson's, Laplace law and magnetic field and its applications
4. To understand the concept of magnetic forces and magnetic materials
5. To understand the applications of Maxwell's equations and time varying fields

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**a) Coulomb's Law and electric field intensity:** Experimental law of Coulomb, Electric field intensity, Types of charge distributions. Field due to various charge distributions-Line charges, Surface charge, Volume charge. Fields due to infinite line charge, charged circular ring, infinite sheet charge. **b) Electric flux density, Gauss' law and divergence:** Electric flux and flux density, Flux density for various charge distributions-Line charge, surface charge, volume charge. Gauss' law, Divergence, Maxwell's First equation (Electrostatics), vector operator and divergence theorem. TEXT 1 TEXT 2 and TEXT 3. Reference Books	12	L1,L2,L3,L4
2	**a) Energy and potential:** Energy expended in moving a point charge in an electric field, The line integral, Definition of potential difference and Potential, The potential field of a point charge and system of charges, Potential gradient, Energy density in an electrostatic field. **b) Conductors and dielectrics:** Current and current density, Continuity of current, metallic conductors, Conductor properties and boundary conditions, boundary conditions for perfect Dielectrics. TEXT 1 TEXT 2 and TEXT 3. Reference Books	10	L1,L2,L3,L4
3	**a) Poisson's and Laplace's equations:** Derivations of Poisson's and Laplace's Equations. Examples of the solutions of Laplace's and Poisson's equations. **b) The steady magnetic field:** Biot-Savart law, Ampere's circuital law, Curl, Stokes' theorem, magnetic flux and flux density, scalar and Vector magnetic potentials. TEXT 1 TEXT 2 and TEXT 3. Reference Books	10	L1,L2,L3,L4
4	**a) Magnetic forces and materials:** Force on a moving charge and differential current element, Force between differential current elements, Force and torque on a closed circuit.	10	L1,L2,L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	b) Magnetic materials: Magnetization and permeability, Magnetic boundary conditions, Magnetic circuit, Potential energy and forces on magnetic materials. TEXT 1 TEXT 2 and TEXT 3. Reference Books		
5	**Time varying fields and Maxwell's equations:** Faraday's law, displacement current, General field relations for time varying Electric and Magnetic fields. Maxwell's equation in point and Integral form. TEXT 1 TEXT 2 and TEXT 3. Reference Books	10	L1,L2,L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note2:
a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT presentation/subject quiz/project/seminar

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Able to define and state the behaviour of static electric fields in standard configurations.

CO2 Able to explain concepts of Energy and Potential to solve numerical problems.

CO3 Able to solve problems on Poisons and Laplace's equations, Biot-savarts law and Circuital laws.

CO4 Able to distinguish the behaviour of Electrostatic and electromagnetic fields between two dielectrics/conductor-dielectric boundaries

CO5 Able to apply Maxwell's equations for real time problems

Course Outcomes Mapping with Programme Outcomes.

Sl.No	**Course Outcome**	**Level of Blooms Taxonomy**	**No. of hours of teaching**	**Programme Outcome**											
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.	**CO1**	**1,2**	**12**	3	3	2	1	1		1			1		2
2.	**CO2**	**1,2**	**10**	3	3	2				1			1		2
3.	**CO3**	**3**	**10**	3	3	2	1				1		1		1
4.	**CO4**	**4**	**10**	3	3	2	1			1			1		1
5.	**CO5**	**5**	**10**	3	3	2	1				1		1		2
Average CO				**3**	**3**	**2**	1	1		1	1		1		2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2
CO2	2	2	2
CO3	2	2	2
CO4	2	2	2

CO5	2	2	2
Average CO	**2**	**2**	**2**

Text Books.

1 S. P. Basavaraju, “Field Theory”, First Edition, Sunstar Publisher, 2014

2 William H Hayt Jr. and John A Buck, “Engineering Electromagnetics”, 7th edition, Tata McGraw-Hill, 2006

3 J A Edminister, “Electromagnetics”, 2nd edition, Tata McGraw-Hill, 2006

Reference Text Books.

1 John Krauss and Daniel A Fleisch , “Electromagnetics with Applications”, 5th edition, Tata McGraw-Hill, 1999

2 Edward C. Jordan and Keith G Balmain, Prentice, “Electromagnetic Waves And Radiating Systems”, 2nd edition, Hall of India, 2008

Web Links.

1 Markus Zahn, “Electromagnetic Field Theory A Problem Solving Approach”, Massachusetts Institute of Technology

2 David H. Staelin, “Electromagnetics and Applications”, Massachusetts Institute of Technology

Subject Title : MICROCONTROLLER

Sub.Code:18EE53	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week :03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1. To understand the concept and Architecture of Microcontroller, logical Instruction & Assembly programming.
2. To learn branching Instructions & C- programming,
3. To learn timer operation, modes of operation, interrupts, serial programming,.
4. The learn programming languages instructions involved call and subroutine function
5. To make use of the Hardware Interfacing of ADC, DAC, Motor, LCD & Keyboard.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**The 8051 Architecture:** Introduction, 8051 microcontroller hardware, input/output pins, ports, circuits, external memory, counter and timers, serial data input/output, interrupts.	7	L2,L3,L4
2	**Addressing Modes and Operations**: Introduction, addressing modes, external data transfer, code memory, read only data moves/indexed addressing mode, push and pop. Data exchanges, example programs; byte level logical operations, bit level logical operations, rotate and swap operations, example programs. arithmetic operations: Flags, incrementing and decrementing, addition ,subtraction, multiplication and division, decimal arithmetic, program examples	8	L2,L3,L4
3	**Jump and Call Instructions:** The Jump and CALL program range, jumps, calls and subroutines, interrupts and returns, more details on interrupts, program example.8051 programming in c: data types and time delays in 8051 c, I/O programming, logic operations, data conversion programs, accessing code ROM space, data serialization.	7	L2,L3,L4
4	**Timer / Counter Programming in 8051**: Programming 8051 Timers, Counter programming, programming timers 0 and 1 using C/assembly language.	8	L2,L3,L4
5	**8051 Serial Communication**: Basics of serial communication, 8051 connections to RS-232, 8051 serial communication programming. **Interrupts Programming:** 8051 Interrupts, programming timer interrupts, programming external hardware interrupts, programming the serial communication interrupts, interrupt priority in the 8051/52. **8051 Interfacing Applications**: Interfacing 8051 to LCD, keyboard, parallel and serial ADC, DAC, stepper motor interfacing, DC motor interfacing and PWM.	9	L2,L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note2: a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

b) Group Activity for 5 Marks has to be evaluated through PPT presentation/subject quiz/project/seminar

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Explain the architecture & difference between Microprocessor & Microcontrollers.
CO2	Use the arithmetic and logical instructions.
CO3	Use the instructions for writing assembly language and C program.
CO4	Use timers in Assembly Language and C program.
CO5	Use interrupts for serial and external peripherals interface.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				a	b	c	d	e	f	g	h	i	j	k	l
1.	CO1	2,3,4	10	3	3	2	2		1						1
2.	CO2	2,3,4	11	3	3	2	2		1						1
3.	CO3	2,3,4	11	3	3	2	2		1						1
4.	CO4	2,3,4	10	3	2	2	2		1						1
5.	CO5	2,3,4	10	3	3	2	2		1						1
Average CO				3	3	2	2		1						1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	3	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 Kenneth J Ayla,, “The 8051 Microcontroller Architecture, Programming & Applications”, 2nd Edition, Thomson Learning l, 2005

2 Muhammad Ali Mazidi, “The 8051 Microcontroller and Embedded Systems-Using Assembly and C”, 2 Vol, PHI Pearson, 2010

3 Manish K Patel,“The 8051 Microcontroller Based Embedded Systems”, 1st Edition, Tata Mcgraw Hill, 2014.

Reference Text Books.

1 K M Bhurchandi, A K Ray, "Advanced Microprocessors and Peripherals: With ARM and an Introduction to Microcontrollers and Interfacing",", 3rd Edition, Tata Mc GrawHill, 2012

2 S.K Mandal, "Microprocessors and Microcontrollers: Architecture, Programming & Interfacing using 8085, 8086, and 8051"", 2nd edition, Tata Mc GrawHill, 2011

3 Salvador PinillosGimenez,S.K Mandal, "8051 Microcontrollers: Fundamental Concepts, Hardware, Software and Applications in Electronics", 1st edition, Springer, 2019

4 S .Subrata Ghoshal.K Mandal, "8051 Microcontroller: Internals, Instructions, Programming and Interfacing", 2nd edition, Pearson, 2010

Web Links.

1 https://www.circuitstoday.com/4-books-to-learn-8051-microcontroller

2 http://web.mit.edu/6.115/www/document/8051.pdf

3 https://www.quora.com/What-are-the-best-books-for-8051-microcontroller

4 https://books.google.co.in/books/about/The_8051_Microcontroller.html?id=l6lveWkWqF

Subject Title : : Electrical Machine Design

Sub.Code: 18EE54	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Assmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1. To introduce the knowledge on basic principles of design, limitations and different materials used in electrical machines.
2. To understand the design concepts of Transformers.
3. To understand the problems on design of Transformers to satisfy the requirements
4. To understand the design concepts of AC and DC rotating electrical machines.
5. To understand the problems on design of AC and DC rotating electrical machines to satisfy the requirements.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Principles of Electrical Machine Design:** Introduction, considerations for the design of electrical machines, limitations. Different types of conducting, magnetic and insulating materials used in electrical machines. Design of Transformers (Single Phase and Three Phase): Output equation for single phase and three phase transformers, choice of specific loadings, expression for volts/turn, determination of main dimensions of the core, types of windings and estimation of number of turns and conductor cross sectional area of primary and secondary windings. TEXT 1 and TEXT 2. Reference Book1	12	L1-L5
2	**Estimation of Leakage Reactance and Tank Design of Transformer:** Estimation of no load current, expression for leakage reactance and voltage regulation. Design of tank and cooling tubes (round and rectangular). TEXT 1 and TEXT 2 Reference Book1	10	L1-L5
3	**Design of DC machines:** Output equation, choice of specific loadings and choice of number of poles, design of main dimensions of the dc machines, design of armature slot dimensions, Commutator and brushes, magnetic circuit - estimation of ampere turns, design of yoke and pole, field windings – shunt, series. TEXT 1 TEXT 2 Reference Book 1	10	L1-L5
4	**Design of induction Motors:** Output equation, choice of specific loadings, main dimensions of three phase induction motor, stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor, design of rotor bars and end ring, design of slip ring induction motor, estimation of no load current. TEXT 1 and TEXT 2. Reference Book1	10	L1-L5

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
5	**Design of Synchronous Machines:** Output equation, choice of specific loadings, short circuit ratio, design of main dimensions, design of the field winding, armature slots and windings, slot details for the stator of salient and non-salient pole synchronous machines. TEXT 1 and TEXT 2. Reference Book1	10	L1-L5

Note 1: Unit 1 to 5 will have internal choice

Note 2:

a) a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 2 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Apply the basic principles of design, and to select the best materials used in electrical machines
CO2	Explain design concepts of static electrical machines.
CO3	Analyse the design concepts of rotating electrical machines for the optimized performance.
CO4	To solve the design problems of static electrical machines.
CO5	To design the rotating electrical machines for the optimized performance.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.	CO1	**2**	**12**	2	3	3	1		1	1	1	1	1	1	1
1	CO2	**2**	**10**	2	3	2	1		1	1	1	1	1	1	1
3.	CO3	**4**	**10**	2	2	3	1		1	1	1	1	1	1	1
4.	CO4	**5**	**10**	2	3	2	1		1	1	1	1	1	1	1
5.	CO5	**5**	**10**	2	3	2	1		1	1	1		1		1
Average Co				2	3	2	1		1	1	1	1	1	1	1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	3	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 . A.K. Sawhney, "A Course In Electrical Machine Design", 4th edition, Dhanpatt Rai & Co, 2016

2 V. N. Mittle, " Performance And Design Of AC Machines ", 4th edition Standard Publishers Distributors

Reference Text Books.

1 M.G. Say, "Performance And Design Of AC Machines", edition, CBS Publishers and Distributors Pvt.Ltd.r, 2002

2 A. Shanmugasundarm, G. Gangadharan, R. Palani, "Design Data Handbook", edition,, year

Web Links.

1 https://www.quora.com/Where-can-I-get-a-A-K-Sawhney-PDF-of-a-course-in-electrical-machine-design

2 https://books.google.co.in/books/about/Design_Of_Electrical_Machines.html?id=7mTRGAAACAAJ

Subject Title : Control System Lab

Sub.Code: 18EEL56	No. of Credits:1=0:0:1 (L - T – P)	No. of Lecture Hours/Week : 02
Exam Duration:3 Hrs	CIE +SEE=50+50=100	Total No.of Contact Hours:26

Course Learning Objectives:

1. To study transient and steady state behaviour of linear control system.
2. To design compensating networks for improvement of stability.
3. To study frequency response of second order system.
4. To study time domain response characteristics of second order system.
5. To study AC/DC servomotor and P,I,D performance.

Expt No	Experiments	No.of Hours	Blooms Taxnomy level.
1.	Simulation of a typical second order system and determination of step response and evaluation of time- domain specifications using a software tool	2	L1-L4
2.	(a) Design of a passive RC lead compensating network for the given specifications, viz., the maximum phase lead and the frequency at which it occurs and to obtain its frequency response. (b) Experimental determination of transfer functions of a lead compensating network.	2	L1-L5
3	(a) Design of a RC lag compensating network for the given specifications. viz., the maximum phase lag and the frequency at which it occurs, and to obtain its frequency response. (b) Experimental determination of transfer functions of a lag compensating network.	2	L1-L5
4	Study of the effect of P, PI, PD and PID controller on the step response of a feedback control system (using control engineering trainer/process control simulator).	2	L1-L4
5	Speed – torque characteristic of a two - phase A.C. servomotor.	2	L1-L4
6	Speed torque characteristic of a D.C. servomotor.	2	L1-L4
7.	Experimental determination of frequency response of a second -order system and evaluation of frequency domain specifications	2	L1-L4
8.	Simulation of a D. C. position control system and its step response.	2	L1-L4
9	Determination of phase margin and gain margin of a transfer function by Bode Plots and verification by simulation.	2	L1-L4
10	Construction of root locus of transfer function and verification by simulation.	2	L1-L4
11	Synchro pair characteristics.	2	L1-L4
	Experiments beyond syllabus		
01	Determination of Observability and Controllability of a system in MATLAB.	2	L1- L4

Expt No	Experiments	No.of Hours	Blooms Taxnomy level.
02	Determination of phase margin and gain margin of a transfer function by Nyquist plot by MATLAB simulation.	2	L1-L4

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Understand and analyze the time and frequency domain specifications for a second order system.

CO2 Analyze the performance of servomotors.

CO3 Evaluating system performance using P,I,D controllers.

CO4 Design the control system with compensators.

CO5 Use MATLAB for simulation and validation of results obtained by analytical calculations.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	**2**	**4**	**3**	**3**		**3**	**3**			**1**		**1**	**1**	**1**
2.	CO2:	**3**	**4**	**3**	**3**		**3**	**3**			**1**		**1**	**1**	**1**
3.	CO3:	**5**	**2**	**3**	**3**		**3**	**3**			**1**		**1**	**1**	**1**
4.	CO4:	**6**	**4**	**3**	**3**	**3**	**3**	**3**			**1**		**1**	**1**	**1**
5.	CO5:	**2**	**8**	**3**	**3**		**3**	**3**			**1**		**1**	**1**	**1**
Average CO				**3**	**3**	**3**	**3**	**3**			**1**		**1**	**1**	**1**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	3	1
CO2	3	3	1
CO3	3	3	1
CO4	3	3	1
CO5	3	3	1
Average CO	**3**	**3**	**1**

Text Books.

1 Matlab user manual, Ogata.

References

1 Matlab by Rudrapratap.

Web Links.

1 http://vlabs.iitkgp.ernet.in/vlabs/vlab4/control/motorcontrol/closedloop/pidcontinuous/clpidc_aim.html

2 http://vlabs.iitkgp.ernet.in/vlabs/vlab4/control/motorcontrol/openloop/ol_aim.html

3 http://ialcoep.vlabs.ac.in/Expt6/Aim.html?domain=Electrical%20Engineering&lab=Industrial%20Automation%20Laboratory

4 http://209.211.220.205/vlabiitece/labs.php

Subject Title : DC MACHINES & SYNCHRONOUS MACHINES LAB

Sub.Code:18EEL57	No. of Credits:1=0:0:1(L - T – P)	No. of Lecture Hours/Week :02
Exam Duration:3 Hrs	CIE +SEE=50+50=100	Total No.of Contact Hours:26

Course Learning Objectives:

1 To introduce various testing methods for DC and synchronous machines.

2 To learn various losses occurring in DC machines and to find efficiency of a DC machines..

3 To learn the characteristics, performance and speed control of DC machines.

4 To determine voltage regulation of synchronous machines by various methods.

5 To study the behaviour of synchronous machine connected to infinite bus bars.

Expt No	Experiments Contents	No.of Hours	Blooms Taxnomy level.
1	Open circuit characteristics of DC machine.	2	L1, L2
2	Load characteristics of a D.C. shunt and compound generator - i) short shunt-cumulative and differential (ii) Long shunt-cumulative and differential.	2	L1,L2,L3.
3	Load test on a DC motor - determination of speed-torque and HP-efficiency characteristics.	2	L1, L2, L3,L4
4	Swinburne’s test.	2	L1, L2, L3,
5	Hopkinson’s test.	2	L1, L2, L3, L4
6	Speed control of DC motor by armature voltage control and flux control.	3	L1, L2, L3, L4
7.	Ward Leonard method of speed control of D.C. motor.	3	L1, L2, L3, L4
8.	Voltage regulation of an alternator by EMF and MMF method.	3	L1, L2, L3, L4
9	Voltage regulation of an alternator by ZPF method.	3	L1, L2, L3, L4
10	Slip test and determination of regulation.	3	L1, L2, L3, L4
11	Performance of synchronous generator connected to infinite bus under constant power and variable excitation.	3	L3.L4
12	V and Inverted V curves of a synchronous motor.		
	Experiments beyond syllabus		
01	Field’s test on series motors.	3	L1, L2, L3, L4
02	Load test on series generator.	3	L1, L2, L3, L4

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Choose proper testing method to determine losses and efficiency of a DC machine and to determine voltage regulation of synchronous generator.

CO2 Explain the characteristics of DC machines and synchronous machines by conducting suitable tests.

CO3 Apply the basic concept for experimental determination of voltage regulation of synchronous generator.

CO4 Analyze the performance of DC machines on load and synchronous machines on infinite bus bars.

CO5 Evaluate the losses and efficiency of DC machines and performance of synchronous machines connected to infinite bus bars.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	**1,2**	**4**	3	3			2				3			1
2.	CO2:	**1 - 3**	**5**	3	3			2				3			1
3.	CO3:	**1 - 3**	**5**	3	3			2				3			1
4.	CO4:	**1 - 4**	**5**	3	3			2				3			1
5.	CO5:	**1 - 4**	**5**	3	3	1		2				3			1
Average CO				3	3	1		2				3			1

Course outcomes mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	3	2	
CO3	3	2	2
CO4	3	2	
CO5	3	2	2
Average CO	**3**	**2**	

References Text Books.

1 Department manual.

Web Links.

1 http://vlab.amrita.edu/?sub=1&brch=75&sim=217&cnt=1

2 http://vlab.amrita.edu/?sub=1&brch=75&sim=322&cnt=1

Subject Title : PROGRAMMABLE LOGIC CONTROLLERS

Sub.Code: 18EE551	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1. The need of automation in the industry with basic controller mechanisms involved.
2. The programming concepts to achieve the desired goal or to define the various steps involved in the automation.
3. The programming languages involved with basic subroutine functions.
4. To make use of the internal hardware circuits of automation circuit to control the devices during various states with monitoring the timers and counters
5. To handle the data of the I/O devices to interface the data with the controller and auxiliary devices.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Introduction:** programmable logic controller (PLC). Role in automation (SCADA). Advantages and Disadvantages, Hardware of PLC, Internal Architecture, Sourcing and Sinking, **Input and Output Devices:** Characteristics of I/O devices, List of input devices- mechanical switches, proximity switches, photoelectric sensor and switches, temperature sensor. Output devices- relay, directional control valve and motor. Examples of applications- conveyor belt, lift and Liquid level monitoring. TEXT 1 and TEXT 2.	8	L1,L2,L3
2	**I/O Processing:** Input unit / Output unit, Signal conditioning- changing voltage level, Remote connection- serial and parallel communication, serial standard. Networks and its types. **Programming**: Ladder Diagrams- PLC ladder programming, Logic Functions, Latching, Multiple Outputs, Function Blocks- Logic gates, Boolean Algebra, Program Examples- Signal lamp task, Valve operation program. TEXT 1 and TEXT 2.	8	L2,L3
3	**Programming Methods**: Instruction Lists- Ladder programs and Instruction lists, Branch codes, Programming Examples- Signal lamp task and Valve operation program. Sequential Function Charts- Branching and convergence. Structured Text- Conditional statement and iteration statements **Internal Relays**: internal relay, ladder programs- programs with multiple input conditions and Latching programs, Battery-Backed relays. TEXT 1 and TEXT 2.	8	L1,L2,L3
4	**ii) Internal relays**: One-Shot Operation, Set and Reset, Program Examples- Fire alarm system and Loading system, Master control relay. **Jump and Call**: jump- jumps within jumps, Subroutines call. **Timers**: Types of Timers, On-Delay Timers, Excluded- sequencing and cascaded timers. Off-Delay Timer, Pulse Timers, Programming Examples- Flashing light and Traffic light sequence. Counters: Forms of	8	L2,L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	Counter, Programming, Counter Application- Counting task. Up and Down counting. TEXT 1 and TEXT 2		
5	**Shift Registers**: Ladder Programs-4-bit shift register, Sequencing Application- sequencing cylinders and keeping track of faulty items. **Data Handling**: Registers and Bits, Data Handling- Data movement, Data comparison, Data Selection. Arithmetic Functions- Conversion BCD-to-binary and binary-to-BCD. TEXT 1	7	L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note 2:
a) a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 2 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Need of automation and its various control strategies with its auxiliary devices.

CO2 Programs for various functional block consisting of multiple inputs and outputs and to control

CO3 Programming issues with subroutines and debugged

CO4 The use of auxiliary units of a controller with hardware exposure.

CO5 The data handling with simple hardware.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	d	e	f	g	h	i	j	k	l
1.	CO1:	L1,L2,L3	8	3	1	1	2								
2.	CO2:	L2,L3,	8	3		2	1							1	
3.	CO3:	L1,L2,L3	8		3	2	1	2							
4.	CO4:.	L2,L3,L4	8	3	1							1		2	2
5.	CO5:	L3,L4	7				3	2		1				1	1
Average CO				3	2	2	2	2		1		1		1	2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1

CO4	3	3	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1. W Bolton, "Programmable Logic Controllers", 5th Edition, Elsevier- newness, 2009.
2. John W Webb, Ronald A Reis, "Programmable Logic Controllers - Principles and Applications", 5th Edition, Pearson Education, 2007

Reference Text Books.

1. L.A.Bryan, E. A Bryan, "Programmable Controller Theory and Applications", 2nd Edition, An Industrial Text Company Publication, 1997.
2. E. A Paar, "Programmable Logic Controllers", 3rd Edition, An Engineers Guide. Newness, 2003.
3. Garry Dunning, "Introduction to Programmable Logic Controller", 3rd Edition , Thomson Asia Pte Ltd. Publication , 2006
4. Rajesh Mehra, Vikrant Vij, "PLCs & SCADA - Theory and Practice", 2nd Edition, laxmi publication, 2017
5. Kevin Collins, "PLC Programming for Industrial Automation", 1st Edition, Kindle, 2016

Web Links.

1. news.mit.edu/topic
2. https://www.allaboutcircuits.com/textbook/digital/chpt-6/programmable-logic-controllers-
3. https://electrical-engineering-portal.com/download-center/books-and-guides/electrica
4. https://onlinecourses.nptel.ac.in
5. https://www.g-w.com/programmable-logic-controllers

Subject Title : VLSI Circuit Design

Sub.Code: 18EE552	No. of Credits:3=3:0:0(L-T-P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1. To introduce the present technology applied in the MOS Fabrication.
2. To design and analyze the basic electrical properties of various transistors and its electrical equivalent models.
3. To teach the students regarding the classical representations of the various transistors and to enable the electrical engineers to calculate the circuit parameters involved in the scaling process
4. Issues arising during the architectural and structural design of a basic sequential and clocked circuit is discussed
5. Be able to design models of moderately sized CMOS circuits that realize specified digital functions

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**A Review of Microelectronics and an Introduction to MOS Technology:** Introduction to Integrated Circuit Technology. Introduction, VLSI Technologies, MOS Transistors, Fabrication, Thermal Aspects, Production of E-Beam Masks. TEXT 1 and TEXT 2. Reference Book 1 & 2	08	L1,L2,L3.
2	**Basic Electrical Properties of MOS and BICMOS Circuit:** Drain to Source Current I_{ds} Versus V_{ds} Relationships- BICMOS Latch Up Susceptibility. MOS Transistor Characteristics, Figure Of Merit, Pass Transistor NMOS And CMOS Inverters, Circuit Model, Latch Up In CMOS Circuits TEXT 1 and TEXT 2. Reference Book 1 & 2	08	L1,L2,L3.
3	**MOS and BICMOS Circuit Design Processes:** MOS Layers, Stick Diagrams, Design, Symbolic Diagrams. **Basic Circuit Concepts and Scaling of MOS Circuits:** Sheet Resistance, Capacitance Layer Inverter Delays, Wiring Capacitance, Choice of Layers. Scaling Model and Scaling Factors- Limitations Due to Current Density. TEXT 1 and TEXT 2. Reference Book 1 & 2	08	L2,L3,L4
4	**Subsystem Design and Layout:** Architectural Issues, Systems Considerations. Examples of Structural Design, Clocked Sequential Circuits. TEXT 1 and TEXT 2. Reference Book 1 & 2	07	L2,L3,L4
5	**Subsystem Design Processes: G**eneral Considerations, Illustration of Design Process, Observations. **Illustration of The Design Process:** Observation On the Design Process, Regularity Design of an ALU Subsystem. Design of 4-	08	L2,L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	Bit Adder, Implementation of ALU Functions. TEXT 1 and TEXT 2. Reference Book 1 & 2		

Note 1: Unit 1 to 5 will have internal choice

Note 2:

c) a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

d) Group Activity for 5 Marks has to be evaluated through PPT Presentation/Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Impart knowledge of MOS transistor theory and CMOS technologies
CO2	Understand different properties of MOS and BICMOS circuits.
CO3	Analyze the design process of MOS and BICMOS circuits along with scaling of MOS circuits..
CO4	Understand and analyse subsystem design and layout.
CO5	To understand the process of subsystem design.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	**1**	**10**	**3**	**1**		**2**				**2**		**2**		**1**
2.	CO2	**2**	**11**	**3**	**1**		**2**				**2**		**2**		**1**
3.	CO3:	**3**	**11**	**3**	**1**		**2**				**2**		**2**		**1**
4.	CO4:	**4**	**10**	**3**	**1**		**2**				**2**		**2**		**1**
5.	CO5:	**5**	**10**	**3**	**1**		**2**				**2**		**2**		**1**
Average CO				**3**	**1**		**2**				**2**		**2**		**1**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	2		1
CO2	2		1
CO3	2	2	1
CO4	2	2	1
CO5	2	2	1
Average CO	2	2	1

Text Books.

1 Neil Weste, "Introduction to CMOS VLSI Design-A Circuits and Systems Perspective", Third Education, Pearson Publisher, 2006

2 Douglas Pucknell & Eshragian, "Basic VLSI Design", Third Education, PHI Publisher, 2009

Reference Text Books.

1. Yuan TaunTak H Ning Cambridge Press,“Fundamentals of Modern VLSI Devices”, South Asia Edition, Cambridge Press Publisher, 2003
2. Wayne wolf,, “Modern VLSI Design”, Third Edition, Pearson Education publisher, 2003

Web Links.

1. https://nptel.ac.in/courses/117/106/117106092/
2. https://www3.nd.edu/~kogge/courses/cse40462-VLSI-fa18/www/links.html
3. https://www.smartzworld.com/notes/vlsi-circuits-and-design-notes-vtu-vcd/

Subject Title : MODERN CONTROL THEORY

Sub.Code: 18EE553	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1. To explain the concepts of basic and modern control system for the real time analysis and design of control systems.
2. To explain and apply concepts of state variables analysis.
3. To study and analyse nonlinear systems.
4. To analyse the concept of stability of nonlinear systems and categorization.
5. To apply the comprehensive knowledge of optimal theory for Control Systems.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**State Variable Analysis and Design**: Introduction, concept of state, state variables and state model, state modelling of linear systems, linearization of state equations. State space representation using physical variables, phase variables & canonical variables. TEXT 1 , TEXT 2 and TEXT 3. Reference Book 1 to 4	8	L1,L2,L3,L4
2	**Derivation of transfer function from state model**, Diagonalization, Eigen values, Eigen vectors, generalized Eigen vectors. Solution of state equation, state transition matrix and its properties, computation using Laplace transformation. TEXT 1, TEXT 2 and TEXT 3. Reference Book 1 to 4	8	L1,L2,L3,L4
3	**Concept of controllability & observability**, methods of determining the same, effect of pole zero cancellation, duality. TEXT 1, TEXT 2 and TEXT 3. Reference Book 1 to 4	7	L1,L2,L3,L4
4	**Pole Placement Techniques**: stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design. TEXT 1, TEXT 2 and TEXT 3. Reference Book 1 to 4	8	L1,L2,L3,L4
5	**Non-linear systems**: Introduction, behaviour of non-linear system, common physical non linearity-saturation, friction, backlash, dead zone, relay, multi variable non-linearity. Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories. TEXT 1, TEXT 2 and TEXT 3. Reference Book 1 to 4	8	L1,L2,L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note2:

a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes:

CO1	Understand the fundamentals of state variables, linear and nonlinear systems.
CO2	Analyze SISO and MIMO systems and obtain the state models.
CO3	Application of Eigen values for derivation of transfer functions.
CO4	Perform analysis on Controllability and Observability.
CO5	Improve stability of a given system by state feedback pole placement techniques.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2**	**8**	**3**	**3**	**1**	**2**	**1**			**2**		**2**		**1**
2.	CO2	**4**	**8**	**3**	**3**	**1**	**2**	**1**			**2**		**2**		**1**
3.	CO3	**3**	**8**	**3**	**3**	**1**	**2**	**1**			**2**		**2**		**1**
4.	CO4	**4**	**7**	**3**	**3**	**1**	**2**	**1**			**2**		**2**		**1**
5.	CO5	**4**	**8**	**3**	**3**	**1**	**2**	**1**			**2**		**2**		**1**
Average CO				**3**	**3**	**1**	**2**	**1**			**2**		**2**		**1**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	3	1
CO2	3	3	1
CO3	3	3	1
CO4	3	3	1
CO5	3	3	1
Average CO	**3**	**3**	**1**

Text Books.

1 M. Gopal, "Digital control & state variable methods.", 3rd Edition, TMH, 2008

2 I. J. Nagarath& M. Gopal, "Control system Engineering", 5th edition, New Age International (P) Ltd, 2007

3 Katsuhiko Ogata, "Modern Control Engineering", 5th Edition, Prentice Hall India, 1997

Reference Text Books.

1 Benjamin C. Kuo & Farid Golnaraghi, "Automatic Control Systems", 8th edition, John Wiley & Sons , 2009

2 D. Roy Choudary, "Modern Control Engineering", 4th reprint, PHI, 2009

3 Dorf & Bishop, "Modern control systems", 11th Edition, Pearson education, 2008

4 Katsuhiko Ogata, "State Space Analysis of Control Systems", 5th edition PHI, 1997

Web Links.

1 http://control.asu.edu/Classes/MMAE543/543Lecture01.pdf

2 http://eacademic.ju.edu.jo/alhusari/Material/ModernControlNotes.pdf

Subject Title : EMBEDDED SYSTEMS

Sub.Code:18EE554	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1. Provide the knowledge about basic concepts of Embedded Systems.
2. Outline the concepts of typical embedded systems
3. Real-time systems: Identify the unique characteristic, explain general structure and define the unique design problems and challenges of real-time system
4. Understand basics, program, design, implement and test an embedded system and issues in designing.
5. Describe the concepts of real time operating system based embedded systems and Design and Development of Embedded Firmware.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Concept of Embedded System:** Introduction, Embedded System vs. General Computing Systems, History of Embedded Systems, Components, classification, skills required. Core of Embedded systems, Embedded Memories ROM variants and RAM. Major applications areas of embedded system, Purpose of Embedded Systems Examples of Embedded systems, 'Smart' Running Shoes from Adidas-The Innovative Bonding of Lifestyle with Embedded Technology. TEXT 1 and Reference Book	08	L1,L2
2	**Technological Aspects of Embedded System:** Interfacing between analog and digital blocks, Signal conditioning, digital signal processing, DAC & ADC interfacing, Signal conditioning using DSP. **Hardware Software Co-Design and Program Modeling:** Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modeling Language, Hardware Software Trade-offs. TEXT 1 and TEXT 2. Reference Book	08	L1,L2
3	**Design Trade Offs Due to Process Incompatibility, Thermal Considerations:** Issues in embedded system design. Design challenge, design technology, trade-offs. Thermal considerations, Embedded Firmware Design Approaches, Embedded Firmware Development Languages. TEXT 1 and TEXT 3. Reference Book	08	L1,L2,L3.
4	**Software aspects of Embedded Systems:** Real time programming Languages, operating systems. Programming concepts and embedded programming in C. Round Robin, Round	07	L1, L2, L3, L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	Robin with interrupts, Real time OS architecture, selecting architecture. Introduction to RTOS, Operating System Basics, Types of OS, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling. TEXT 1 and TEXT 2. Reference Book		
5	**Subsystem interfacing:** External system, user interfacing and Serial I/O devices, Parallel port interfaces: Input switches, Key boards and Memory interfacing. Trends in the Embedded Industry: Processor Trends in Embedded System, Embedded OS Trends, Development Language Trends, Open Standards, Frameworks and Alliances, Bottlenecks. TEXT 1 and TEXT 2. Reference Book	08	L1, L2, L3, L4

Note 1: Unit 1 to 5 will have internal choice

Note2:
a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 4 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Apply the knowledge of Microcontrollers to understand & explain the concepts of Embedded systems

CO2 Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems.

CO3 Design and Develop domain specific Embedded system applications.

CO4 Demonstrate understanding the facts of issues in embedded system design.

CO5 Design real time embedded systems using the concepts of RTOS and Analyze various examples of embedded systems by using the interfacing method.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2**	**08**	**2**	**1**	**1**	**2**				**2**	**1**	**2**		**2**
2.	CO2	**2**	**08**	**3**	**3**	**1**	**1**				**2**		**2**		**2**
3.	CO3	**5**	**08**	**2**	**3**	**3**	**2**	**2**			**2**	**2**	**2**	**3**	**3**
4.	CO4	**4**	**07**	**3**	**3**	**1**	**2**				**2**		**2**		**3**
5.	CO5.	**5**	**08**	**3**	**3**	**1**	**2**				**2**		**2**		**3**
Average CO				**3**	**3**	**1**	**2**	**2**			**2**	**1**	**1**	**1**	**3**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	1		
CO2	3	2	1

CO3	3	3	2
CO4	3	2	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 Raj Kamal, "4.Embedded System, Architecture, Programming and Design", 2nd Edition, TMH, 2008

2 Valvano, J.W, "Embedded Microcomputer systems: Real time interfacing", 2nd Edition 5th Indian reprint, 2009

3 Shibu K V "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2009

Reference Text Books.

1 Frank Vahid/Tony Givargis, "A Unified Hardware/Software Introduction", Wiley student edition 2002. Choose an item., Choose an item.

2 Simon David, "Embedded Software Premier", Addison Wessly 2000.

Web Links.

1 Motorola and Intel Manuals

2 www.nptel.com

Subject Title : Power Systems Analysis - I

Sub.Code: 18EE61	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Assignment +SEE=40+5+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1 Modelling of power system elements and representing the power system by single line diagrams.

2 Use symmetrical components in power system analysis.

3 Perform fault analysis on power system network.

4 Perform stability analysis on power system network

5 Evaluate the performance of induction machine under unbalanced supply conditions.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Representation of Power System Components:** Circuit models of transmission line, synchronous machines, transformers and load. Single line diagram, impedance and reactance diagrams. Per unit system, per unit impedance diagram of power system. **Symmetrical 3 - Phase Faults:** Transient, sub transient and steady state reactance's and currents of synchronous machines. Short-circuit currents of synchronous machines and power system, short circuit capacity of a bus. Selection of Circuit Breakers. TEXT 1,2 and Reference Book 1 & 4	12	L1-L4
2	**Symmetrical Components:** Introduction, three phase operator-a. Synthesis of unbalanced vector from its symmetrical components. Resolving the unbalanced phasors into their symmetrical components. Relation between symmetrical components of line & phase voltages in star connected system and line & phase currents in delta connected system. Phase shift of symmetrical components in transformer banks. Power in terms of symmetrical component. Analysis of unbalanced system using symmetrical components. Positive, negative and zero sequence networks of power system TEXT 1,2 and Reference Book 1	10	L1-L4
3	**Unsymmetrical Faults:** Introduction. Single line to ground fault (LGF), line to line fault (LLF) and double line to ground fault (LLGF): Determination of faults currents, terminal currents & voltages and connection of sequence networks. Fault with fault impedance. Fault on loaded synchronous generator. Unsymmetrical faults on power system. TEXT 1,2 and Reference Book 2 & 3	10	L1-L5
4	**Concept of System Stability:** Introduction, classification of stability, steady state and transient stability. Power angle equation of salient and non-salient pole machines. Power angle curves. Stability limits and methods to improving the stability. Rotor	10	L1-L5

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	dynamics and the swing equation. Equal area criterion and critical clearing angle & time. Apply equal area criterion for transient stability evaluation under different operating conditions of power system. TEXT 1,2 and Reference Book 3		
5	**Unbalanced Operation of Three Phase Induction Motors:** Open conductor faults in power system: sequence network connections. Analysis of three phase induction motor with one line open. Analysis of three phase induction motor with unbalanced supply. TEXT 2 Reference Book 3,4	08	L1-L5

Note 1: Unit 1 to 5 will have internal choice

Note 2:
a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group activity for 5 marks has to be evaluated through PPT presentation/ Subject Quiz/ Project/ Seminar

Note:3 Out of 5 Units, Unit 3 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Able to, recall the equivalent circuits of power system components and to draw the single line & impedance diagrams of power system network.

CO2 Apply concept of symmetrical components to power system network.

CO3 Analyze the behaviour of power system under different fault conditions.

CO4 Evaluate the steady state and transient stability of the Power Systems.

CO5 Investigate the effect of unbalanced operation and single phasing on the performance of three phase induction machines.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	2	08	3	2	2	3					1			2
2.	CO2:	3	08	3	2	2	2					1			2
3.	CO3:	4	08	3	2	3	2	1	1	2			1	2	2
4.	CO4:	5	08	3	3	3	3	1				1			2
5.	CO5:	5	07	3	3	3	1		1	1		1			1
Average CO				3	3	3	2		1	1		2	1	1	2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		1
CO2	3	2	1
CO3	3	2	1

CO4	3	2	1
CO5	3	2	
Average CO	**3**	**2**	**1**

Text Books.

1 W.D.Stevenson, "Elements of Power System Analysis", Fourth Edition, TMH, 2013

2. I.J.Nagrath and D.P.Kothari, "Modern Power System Analysis", 3rd Edition TMH, 2003

Reference

1 Hadi Sadat "Power System Analysis", Second Edition, TMH, 2009

2 R.Bergen, and Vijay Vittal, "Power System Analysis", 2nd edition, CRC Press, 2006.

3 G.L. Kusic. "Computer Aided Power system analysis", PHI.Indian Edition, 2010

4 W.D. Stevenson & Grainger, "Power System Analysis", Clarendon Press, Oxford, 1989.

5 Naser A and Boldea I, "Linear Electric Motors: Theory", First Edition,Prentice, 2003

Web Links.

1 https://onlinecourses.nptel.ac.in/https://www.eeeguide.com/analysis-of-unsymmetrical-faultshttps://www.eeeguide.com/analysis-of-unsymmetrical-faults//

2 https://www.bvmengineering.ac.in/syllabi/UG1920/EE/3EE02.pdf

3 http://www.brainkart.com/subject/Special-Electrical-Machines_185/

Subject Title : High Voltage Engineering

Sub.Code: 18EE62	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Assignment +SEE=45+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 To introduce the need and basics and Applications of high voltage engineering.

2 Students will learn the break down mechanisms of insulating media.

3 Students will learn the concepts on generation of High AC. DC and impulse voltages and currents.

4 To learn techniques of measurement of High AC, DC and impulse voltages and currents.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Introduction:** Introduction to HV technology, role of insulation in electrical apparatus, types and applications of insulating materials used in transformers and Bushings and Rotating electrical machines. Need for generating high voltages in laboratory. Industrial applications of high voltages. **Conduction and breakdown in gaseous dielectrics:** Ionization: primary and secondary ionization processes. Criteria for gaseous insulation breakdown based on Townsend's theory. Limitations of Townsend's theory. Streamer's theory of breakdown in non-uniform fields. Corona discharges. Breakdown in electro negative gases. Paschen's law and its significance. Time lags of breakdown. **Solid dielectrics**: Breakdown in solid dielectrics: intrinsic breakdown, avalanche breakdown, thermal breakdown, and electro mechanical breakdown. **Liquid dielectrics**: Breakdown of liquid dielectrics: Suspended particle Theory, Cavity breakdown (Bubble's theory), and Stressed Oil Volume theory. Eco-friendly liquid dielectrics: introduction, Characteristic properties, advantages and disadvantages. TEXT 1 and TEXT 2. Reference 1	10	L1, L2, L3
2	**Generation of HVAC voltages:** HVAC-HV transformer; need for cascade connection and working of transformers units connected in cascade. Series resonant circuit- principle of operation and advantages. Tesla coil. **Generation of HVDC voltages:** Half and full wave rectifier circuits**,** voltage doubler circuit, Cockroft-Walton type high voltage generator set. Determination of voltage regulation, ripple and optimum number of stages for minimum voltage drop. Electrostatic generators - Van–de-Graff generator. TEXT 1 and TEXT 2 Reference 1	07	L1 -L4
3	**Generation of impulse voltage and current:** Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator-expression for output impulse voltage. Multistage impulse generator, working of modified Marx	8	L1-L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	multi stage impulse generator circuit. Rating of impulse generator. Components of multistage impulse generator. Triggering of impulse generator by three electrode gap arrangement. Trigatron gap and oscillograph time sweep circuits. Generation of switching impulse voltage generation of high impulse current. .TEXT 1 TEXT 2 Reference 1		
4	**Measurement of high voltages:** Electrostatic voltmeter-principle, construction and limitation. Chubb and Fortescue method for HVAC measurement. Generating voltmeter- principle, construction. Series resistance micro ammeter for HVDC measurements. Standard sphere gap- measurement of HVAC, HVDC, and impulse voltages; factors affecting the measurements. Potential Dividers-Resistance dividers, Capacitance dividers and mixed RC potential dividers. Measurement of high impulse currents- Magnetic links. TEXT 1 and TEXT 2. Reference Book 1	7	L1-L4
5	**High voltage tests on electrical apparatus**: Definitions of terminologies, tests on Insulators, Bushings and Transformers. Partial discharge measurements: Introduction, terminology used, methods of discharge detection- Straight discharge detection method and Balanced detection method. TEXT 1 and TEXT 2. Reference Book 1	7	L1-L5

Note 1: Unit 1 to 5 will have internal choice

Note 2:
a) a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 2 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Explain the need for high voltages and currents

CO2 Explain the physics of break down mechanisms of insulating media.

CO3 Compare the merits and demerits of generation of high voltage and currents.].

CO4 Select suitable method for measurement of high voltages and currents.

CO5 Explain the method of conducting the high voltage tests on different electrical equipment.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	1	10	3	2	1				1			1		1
2.	CO2	2	7	3	2	1				1			1		1
3.	CO3	4	8	2	3	1			1	1			1		1
4.	CO4	5	7	2	1	3			1	1			1		1

5.	CO5	5	7	3	2	1				1			1		1
Average CO				3	2	2			1	1			1		1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	2	2	1
CO3	3	1	1
CO4	2	1	1
CO5	3	1	1
Average CO	3	1	1

Text Books.

1 M.S.Naidu and Kamaraju, " High Voltage Engineering", 4th edition, TMH, , 2008

2 E.Kuffel and W.S. Zaengl, " High Voltage Engineering Fundamentals", 2nd Edition Elsevier Press, 2005.

Reference Text Books.

1 R.S. Jha, " High Voltage Engineering", edition, Dhanpat Rai & Sons, New Delhi , 1996

2 Mazen Abdel-Salam, Hussein Anis, Ahdab El- Morshedy, RoshdyRadwan, " High Voltage Engineering Theory and Practice", 2nd Edition,, 2003

Web Links.

1 https://www.academia.edu/12268238/High_Voltage_Engineering_CL_Wadhwa_PDF_BOok_Download

2 https://www.mv.helsinki.fi/home/tpaulin/Text/hveng.pdf

Subject Title : Digital Signal Processing

Sub.Code: 18EE63	No. of Credits:04=03:02:0 (L - T – P)	No. of Lecture Hours/Week : 05
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:65

Course Learning Objectives:

1 To understand DFT and its properties.

2 To learn FFT algorithm to find DFT.

3 To understand the structure of IIR & FIR system.

4 To learn Digital IIR filter design using analog filter transformation the applications of Fourier transform.

5 To learn Digital FIR filter design.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Discrete Fourier Transforms:** Definitions, properties-linearity, shift, symmetry etc., circular convolution – periodic convolution, use of tabular arrays, circular arrays, stock hams's method, linear convolution – two finite duration sequence, one finite & one infinite duration, overlap add and save methods. TEXT 1 and TEXT 2. Reference Book	13	L1,L2,L3.
2	**Fast Fourier Transforms Algorithms:** Introduction, decimation in time algorithm, number of computations, number of multiplications, computational efficiency, decimation in frequency algorithms, inverse decimation in time and inverse decimation in frequency algorithms, decomposition for a composite number N=9. TEXT 1 and TEXT 2. Reference Book	13	L1,L2,L3.
3	**Realization of Digital Systems:** Introduction, block diagrams and SFGs, realization of IIR systems- direct form, cascaded, parallel form, realization of FIR systems – direct form, cascade form, linear phase realization. TEXT 1 and TEXT 2. Reference Book	13	L1,L2,L3.
4	**Design of IIR Digital Filters:** Introduction, impulse invariant & bilinear transformations, all pole analog filters- Butterworth &chebyshev, design of digital Butterworth & chebyshev, frequency transformations. TEXT 1 and TEXT 2. Reference Book	13	L1,L2,L3.
5	**Design of FIR Digital Filters:** Introduction, windowing, rectangular, modified rectangular, Hamming, Hanning, blackman window(excluding Kaiser window), frequency sampling techniques.	13	L1,L2,L3.

Note 1: Unit 1 to 5 will have internal choice

Note2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5 and Group Activity for 5 Marks

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit and will be delivered by subject faculty.

Course Outcomes:

CO1 Analyse and find DFT of signals.

CO2 Analyse and find DFT using FFT algorithms.

CO3 Realize structures for FIR & IIR systems.

CO4 Design IIR filters for the given specifications.

CO5 Design FIR filters for the given specifications.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:.	1,2,3	13	3	3		2				1		1		1
2.	CO2.	1,2,3	13	3	3		2				1		1		1
3.	CO3:	1,2	12	3	3		2				1		1		1
4.	CO4:	3,4,5	13	3	3	2	2				1		1		1
5.	CO5:	3,4,5	14	3	3	2	2				1		1		1
Average CO's				3	3	2	2				1		1		1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	1	1
CO2	3	2	1
CO3	3	1	1
CO4	3	2	1
CO5	3	2	1
Average CO	3	2	1

Text Books.

1 Dimitris Manolakis and Johm G Proakis, “Digital Signal Processing Principle, Algorithm & application ”, 4th education, Pearson, 2009

2 Sanjeet. K. Mitra , “Digital Signal Processing ”, 3rd edition, TMH, 2009

Reference Text Books.

1 Johnny R. Johnson , “Introduction to Digital Signal Processing ”, 4th edition , PHI, 2009

2 Alan V Oppenheim, Ronald W. Schafer and John R Buck, “Discrete Time Signal Processing ”, 2nd edition , Pearson, 2009

3 S.Salivahanan, A.Vallaraj, C.Gnanapriya , “Digital Signal Processing” Second edition Tata McGraw Hill 2010

Web Links.

1. https://usermanual.wiki/Document/SOLUTIONMANUAL4thDigitalSignalProcessingProakisandManolakis.530579026/help
2. https://www.engineeringbookspdf.com/digital-signal-processing-ramesh-babu/

Subject Title : Digital Signal Processing Lab

Sub.Code: 18EEL65 | No. of Credits:1=0:0:1 (L - T – P) | No. of Lecture Hours/Week : 02
Exam Duration:3 Hrs | CIE +SEE=50+50=100 | Total No.of Contact Hours:26

Course Learning Objectives: Students will learn

1. To write program for computation of DFT, Circular Convolution & Linear convolution
2. To write program to find Impulse response of LTI system.
3. To write program for IIR filter design.
4. To write program for FIR filter design

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Direct Computation of N-point DFT.	2	L1, L2
2	IIR filter realization using cascade form, Parallel form	2	L1,L2,L3.
3	IIR Filter Design using Butterworth method.	2	L1, L2, L3,L4,L5
4	IIR Filter Design using Chebyshev type 1 prototype.	2	L1, L2, L3, L4,L5
5	FIR Filter Design using rectangular, hamming, window.	2	L1, L2, L3, L4,L5
6	FIR Filter Design using Hanning, Blackman window.	2	L1, L2, L3, L4,L5
7.	N-Point Circular Convolution and Proof in frequency domain.	2	L1, L2, L3
8.	Circular Convolution, Linear Convolution and Linear Convolution using Circular Convolution.	2	L1, L2, L3
9	Sampling Theorem.	2	L1, L2, L3
10	Impulse response from X[n] and y[n].	2	L1, L2, L3
11	Impulse response from difference equation and response to x[n].	2	L1, L2, L3
	Experiments beyond the Syllabus		
1	N-point DFT using decimation in Time and Frequency FFT.	2	L1, L2, L3
2	N-point IDFT using decimation in Time and Frequency FFT.	2	L1, L2, L3

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes: The Students will be able to

CO1 Write & execute the program to find DFT, Circular Convolution & Linear convolution
CO2 Write & execute program to find Impulse response of LTI system.
CO3 Differentiate & Write program for FIR & IIR Filter Structures

CO4 Design & Write program for IIR filters.
CO5 Design & Write program for FIR filters.

Course outcomes Mapping with Programme Outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	2	08	3	3		1	2			2	2	2	2	1
2.	CO2:	2	06	3	3		1	2			2	2	2	2	1
3.	CO3:	2,3	02	3	3		1	2			2	2	2	2	1
4.	CO4:	3,4,5	06	3	3	3	2	2			2	2	2	2	1
5.	CO5:	3,4,5	04	3	3	1	2	2			2	2	2	2	1
Average CO				3	3	2	1	2			2	2	2	2	1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	3	1
CO2	3	3	1
CO3	3	3	1
CO4	3	3	1
CO5	3	3	1
Average CO	**3**	**3**	**1**

Text Books.& References

1 S.Salivahanan, A.Vallaraj, C.Gnanapriya , "Digital Signal Processing ", Second Edition, Newnes , 2010

2 Robert J Schilling and Sandra L Harris, "Fundamentals of Digital Signal Processing using MATLAB", India Edition, Cengage Learning,2005.

3 Digital Signal Processing user Manual

Web Links.

1 http://www.geethanjaliinstitutions.com/engineering/labmanuals/downloads/ece/dsp%20lab.pdf

2 http://eceweb1.rutgers.edu/~orfanidi/ece348/labs-2011.pdf

Subject Title: MICROCONTROLLER LAB

Sub.Code:18EEL66	No. of Credits:1=0:0:1(L - T – P)	No. of Lecture Hours/Week :02
Exam Duration:3 Hrs	CIE +SEE=50+50=100	Total No.of Contact Hours:26

Course Learning Objectives:

1. To provide a practical introduction to microcontrollers assembly language & embedded C programming techniques, hardware interfacing circuit.
2. To explain writing ALP for data transfer, arithmetic, Boolean and logical instructions.
3. To explain writing assembly language programs for code conversions..
4. To perform interfacing of stepper motor and dc motor for controlling the speed.
5. To explain generation of different waveforms using DAC interface.

Expt No	Experiments Contents	No.of Hours	Blooms Taxnomy level.
I. PROGRAMMING:			
1	Data Transfer - Block move, Exchange, Sorting, Finding largest element in an array.	2	L2,L3,L4
2	Arithmetic Instructions - Addition/subtraction, multiplication and division, square, Cube – (16 bits Arithmetic operations – bit addressable).	2	L2,L3,L4
3	Counters.	2	L2,L3,L4
4	Boolean & Logical Instructions (Bit manipulations).	2	L2,L3,L4
5	Conditional CALL & RETURN.	2	L2 L3,L4
6	Code conversion: BCD – ASCII; ASCII – Decimal; Decimal - ASCII; HEX - Decimal and Decimal - HEX.	2	L2,L3,L4
7	Programs to generate delay, Programs using serial port and on-Chip timer / counter.	2	L2,L3,L4
II. INTERFACING 8051 CHIP USING C PROGRAMS			
8	Simple Calculator using 6 digit seven segment display and Hex Keyboard.	2	L2,L3,L4
9	Alphanumeric LCD panel and Hex keypad input.	2	L2,L3,L4
10	External ADC and Temperature control.	2	L2,L3,L4
	Experiments beyond the syllabus		

Expt No	Experiments Contents	No.of Hours	Blooms Taxnomy level.
1	Generation of different waveforms - Sine, Square, Triangular, Ramp etc. using DAC; changing the frequency and amplitude	2	L2,L3.L4
2	Stepper and DC motor control.	2	L2,L3.L4

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Understand different instruction set and architecture of 8051 Microcontroller.

CO2 Write &Analyze assembly language programming.

CO3 Understand usage of directives, Code Memory & external memory.

CO4 Write assembly language program using bit instructions.

CO5 Build Interfacing Circuit using embedded C programming.

Course outcomes Mapping with Programme Outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	2,3,4	2	3	1	1			2						2
2.	CO2:	2,3,4	2	3	1	1			2						2
3.	CO3:	2,3,4	2	3	1	1			2						2
4.	CO4:	2,3,4	2	3	1	1			2						2
5.	CO5:	2,3,4	2	3	1	1			2						2
Average CO				3	1	1			2						2

Course outcomes Mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	3	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books & References:

1 Kenneth J Ayla, “Operate The 8051 Microcontroller Architecture, Programming & Applications System Principles”, 2nd Edition, Penram International, Thomson Learning, 2005

2 Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D McKinlay, “The 8051 Microcontroller and Embedded Systems-Using Assembly and C”, 2nd Edition, Pearson Publisher, 2006

Web Links.

1 https://www.svec.education/courses/eee-course-material-lab-manuals/

2. https://hsit.ac.in/dept-doc/EE/lab-manual/15EEL57-MC-LAB-MANUAL.pdf

Subject Title : Special Electrical Machines

Sub.Code: 18EE642	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Assignment +SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 To understand the constructional aspects of Special electrical machines
2 To understand the speed torque characteristics of Special electrical machines
3 To analyse the necessity of sensors used in Special electrical machines
4 To understand the concepts of converters and control schemes of Special electrical machines
5 To understand the merits, demerits and applications of Special electrical machines

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Stepper Motor:** Types of motors, construction, working principle. Term & definitions- Step angle, resolution, slewing, etc. Excitation modes, switching circuits, open and closed loop control, torque equation, speed torque characteristic, digital control of motor, comparison and applications of stepper motors. TEXT 1 and Reference Book 1 & 4	08	L1-L4
2	**Switched Reluctance Motor (SRM):** Construction, working principle, Inductance profile, pole arc and tooth arc constraints, torque equation, characteristics, power converter circuits, sensors-Hall and Optical, current regulators, sensor less and digital control, merits, demerits and applications. TEXT 1 and Reference Book 2	08	L1-L4
3	**Brushless Permanent Magnet DC (BLDC) Motor:** Introduction to PMDC motors. BLDC motors: Classification, construction, principle of operation, types of motor, electronic commutation, emf equation and waveforms, Torque equation, sensors, sensor less and digital control, comparison of brushed and brushless dc motors, merits, demerits and applications. TEXT 1 and Reference Book 2 & 3 Reference Book 2	08	L1-L5
4	**Permanent Magnet Synchronous Motor (PMSM):** Construction, principle of operation, emf equation, torque equation, sensor less and digital control, phasor and circle diagrams, comparison with conventional motors, applications. TEXT 1 and Reference Book 3	08	L1-L5
5	**Linear Induction Motor and Axial Flux Machines:** LIM: Construction, types, Principle of operation, thrust equation, and applications. **AFM:** Construction, types, Principle of operation, windings, torque and emf equations, applications. TEXT 1 and Reference Book 5	07	L1-L5

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.

Note 1: Unit 1 to 5 will have internal choice

Note 2:

c) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

d) Group activity for 5 marks has to be evaluated through PPT presentation/ Subject Quiz/ Project/ Seminar

Note:3 Out of 5 Units, Unit 3 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Able to describe the construction and operation of different special electrical machines
CO2	Compare merits, demerits of different special electrical machines and their applications.
CO3	Analyse different power converter topologies for operation of special electrical machines
CO4	Formulate the torque equation and analyze speed –torque characteristics of special electrical machines.
CO5	Develop digital control techniques for the operation and control of special electrical machines.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.	CO1:	**2**	08	**3**	**3**	**2**	**1**	**2**	**2**			**1**	**1**		**2**
2.	CO2:	**3**	08	**3**	**3**	**2**	**1**	**2**	**2**			**1**			**2**
3.	CO3:	**4**	08	**3**	**3**	**2**	**1**	**2**		**2**			**1**		**2**
4.	CO4:	**5**	08	**3**	**3**	**2**	**1**	**2**							**2**
5.	CO5:	**5**	07	**3**	**3**	**2**	**1**	**2**	**1**	**1**					**2**
Average CO				3	3	3	2		1	1		2	1	1	2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	
Average CO	3	2	1

Text Books.

1 E.G. Janardhanan, "Special Electrical Machines", First Edition, PHI, 2009

Reference Text Books.

1 K. Venkataratnam "Special Electrical Machines", First, University Press, 2009

2 R.Krishnan, "Switched Reluctance motor Drives Modeling, Simulation" Analysis, Design, and Applications, CRC Press, 2015.

3 Miller, T.J.E. "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989

4 Kenjo, T, "Stepping Motors and their Microprocessor control", Clarendon Press, Oxford, 1989.

5 Naser A and Boldea I, "Linear Electric Motors: Theory, Design and Practical Application", Prentice Hall Inc., New Jersey,1987

Web Links.

1 https://onlinecourses.nptel.ac.in/

2 https://www.academia.edu/9885014/SPECIAL_ELECTRICAL_MACHINES_NPTEL_NOTES

Subject Title : Artificial Intelligence Techniques for Electrical Engineering

Sub.Code: 18EE643 | No. of Credits03=03:0:0 (L - T – P) | No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs | CIE+Assmt+GA +SEE=40+5+5+50=100 | Total No.of Contact Hours:39

Course Learning Objectives:

1 To locate soft commanding methodologies, such as artificial neural networks, Fuzzy logic and genetic Algorithms.

2 To observe the concepts of feed forward neural networks and about feedback neural networks.

3 To practice the concept of fuzziness involved in various systems and comprehensive knowledge of fuzzy logic control and to design the fuzzy control.

4 To analyse genetic algorithm, genetic operations and genetic mutations.

5 To learn application of AI to power systems.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Artificial Neural Networks:** Introduction-Models of Neural Network – Architectures – Knowledge representation – Artificial Intelligence and Neural networks – Learning process – Error correction learning – Hebbian learning – Competitive learning – Boltzmann learning – Supervised learning – Unsupervised learning – Reinforcement learning – learning tasks. TEXT 1 and 2. Reference 1 - 4	07	L1 -L4
2	**ANN Paradigms:** Multi – layer perceptron using Back propagation Algorithm-Self – organizing Map – Radial Basis Function Network – Functional link, network – Hopfield Network. TEXT 1 and 2. Reference 1 - 4	08	L1 -L4
3	**Fuzzy Logic:** Introduction – Fuzzy versus crisp – Fuzzy sets – Membership function – Basic Fuzzy set operations – Properties of Fuzzy sets – Fuzzy Cartesian Product – Operations on Fuzzy relations – Fuzzy logic – Fuzzy Quantifiers – Fuzzy Inference – Fuzzy Rule based system – Defuzzification methods. TEXT 1 and 2. Reference 1 - 4	08	L1-L4
4	**Genetic Algorithms:** Introduction-Encoding – Fitness Function-Reproduction operators – Genetic Modeling – Genetic operators – Crossover – Single–site crossover – Two-point crossover – Multi point Crossover-Uniform crossover – Matrix crossover – Crossover Rate – Inversion & Deletion – Mutation operator – Mutation – Mutation Rate-Bit-wise operators – Generational cycle-convergence of Genetic Algorithm. TEXT 1 and 2. Reference 1 - 4	08	L1 -L4
5	**Applications of AI Techniques:** Load forecasting – Load flow studies – Economic load dispatch – Load frequency control – Single area system and two area system – Small Signal Stability	08	

	(Dynamic stability) Reactive power control – speed control of DC and AC Motors. TEXT 1 and 2. Reference 1 - 4		

Note 1: Unit 1 to 5 will have internal choice

Note 2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

CO1 Understand feed forward neural networks, feedback neural networks and learning techniques.

CO2 Analyze fuzziness involved in various systems and fuzzy set theory.

CO3 Develop fuzzy logic control for applications in electrical engineering

CO4 Develop genetic algorithm for applications in electrical engineering

CO5 Apply AI to study and analyse power system problems.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	1 - 4	07	3	3	3	2	3							1
2.	CO2	1 - 4	08	3	3	3	2	3							1
3	CO3	1 - 4	08	3	3	3	2	3							1
4.	CO4	1 - 4	08	3	3	3	2	3							1
5.	CO5	1 - 4	08	3	3	3	2	3							1
Average COs				3	3	3	2	3							1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	
Average CO	3	2	1

Text Books.

1 D.W.Patterson, "Introduction to Artificial Intelligence and Expert Systems", PHI, 2009

2 S. Rajasekaran and G. A. V. Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms", 13th Edition, PHI, New Delhi, 2003

Reference Text Books.

1 P. D. Wasserman, Van Nostrand Reinhold, "Neural Computing Theory & Practice", Newyork, 1989

2 Bart Kosko, "Neural Network & Fuzzy System", , PHI, Pvt.Ltd, 1992

3 G. J. Klir and T. A. Folger, **“**Fuzzy sets, Uncertainty and Information**”**, 2 nd edition, PHI Private Limilted, 1994
4 D. E. Goldberg, **“**Genetic Algorithms**”**, Addison Wesley 1999

Web Links.

1 https://nptel.ac.in/

Subject Title : Electric Vehicle Technology

Sub.Code: 18EE644	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 Understand and acquire knowledge of battery driven electric vehicle, characteristics and their applications.

2 Acquire knowledge about vehicle dynamics, Motors, Power Electronics, Batteries, and Charging

3 Study the performance of different types of electric drives.

4 Learn vehicle dynamics with constant and variable parameters

5 Analyse through Mat lab/ Simulink tool in real time applications.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Introduction to Electric Vehicle:** History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Introduction to: Motor Drive Technologies; Energy Source Technologies; EV Battery Charging Technologies, Comparison of energy diversification of different types of vehicles. TEXT 1 and TEXT 2. Reference Book 1	07	L1,L2,L3.
2	**Intro EV Subsystems and Configurations:** Basics of vehicle performance; HEV Subsystems and Configurations; Modes of Operation: Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis. TEXT 1 and TEXT 2. Reference Book 1	08	L1,L2,L3.
3	**Vehicle Dynamics 1:**Mathematical models to describe vehicle performance; system level design & component level design, force-speed characteristics; tractive effort- gravitational force, air friction, the resistance offered by tire, rolling resistance etc.; different types of EV motors used for electric vehicle. TEXT 1 and TEXT 2. Reference Book 2	08	L2,L3.
4	**Vehicle Dynamics 2:**Dynamic equation with constant Fte-constant Tractive effort, terminal velocity, average power; Dynamic equation variable Fte- derivation of different dynamic equations with variable FTE- variable tractive effort and different regions of vehicle speeds. TEXT 1 and TEXT 2. Reference Book 2	08	L3,L4.
5	**Vehicle Dynamics Modelling and simulation:** Simulation of Vehicle dynamic equation constant Fte; Simulation of Vehicle dynamic equation variable Fte. Vehicle Dynamics Modelling and Simulation in Mat Lab/Simulink with real time application.	08	L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	TEXT 1 and TEXT 2. Reference Book 2		

Note 1: Unit 1 to 5will have internal choice

Note2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2.
a)Assignment -2 from Units 3, 4 and 5
b)Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 5is a Webinar unit conducted through Google Classroom/ Zoom/Cisco-Webex.., and will be delivered by subject faculty.

Course Outcomes:

CO1 Summarize the fundamental concepts of Electric Vehicles.

CO2 Understand principles of operation of hybrid and electric vehicles.

CO3 Analyze the Electric Vehicle dynamics with constant and variable parameters.

CO4 Apply Electric Vehicle dynamics for real time applications

CO5 Create dynamic model of Electrical vehicle using simulation tools

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	L1,L2,L3	09	3	2		1							1	
2.	CO2	L1,L2,L3	12	3		1	2	1							
3.	CO3	L2,L3	09				2						1	1	1
4.	CO4	L3,L4	9	3			1	1							1
5.	CO5	L3,L4	4	3		3				3					3
Average COs				3	2	2	2	1		3			1	1	2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcomes	PSO1	PSO2	PSO3
CO1	2	2	2
CO2	1	1	1
CO3	2	1	2
CO4	2	2	2
CO5	3	3	3
Average COs	2	2	2

Text Books.

1 Iqbal Husain,“ Electric and Hybrid Vehicles, Design Fundamentals”,CRC Press,2003

2 M. Ehsani, Y. Gao, S. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles” CRC Press,2005.

Reference Text Books.

1 Tom Denton. , “Electric And Hybrid Vehicles” Routledge / Taylor & Francis Group 2016.

2 Donald L Anglin & William H. Crouse, “Automotive Mechanics” ,McGraw-Hill,1985

3 Sira -Ramirez, R. Silva Ortigoza ,“Control Design Techniques in Power Electronics Devices”,Springer

Web Links.

1 https://swayam.gov.in/nd1_noc20_ee18

2 https://youtu.be/Ay-4AZTnTEQ

3. Electric Vehicle Part -1,Dr Amit Jain,IIT Delhi. https://nptel.ac.in/courses/108/102/108102121/

Subject Title : SMART GRID TECHNOLOGY

Sub.Code: 18EE645	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 3
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives: After completion of the course, the student will be able to

1. Understand the features of smart grid
2. Study various smart transmission and distribution technologies
3. Appreciate distribution generation and smart consumption
4. Know the regulations and market models for smart grid..
5. Understand the distributed energy resources, home energy management systems

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Introduction to Smart Grids**: Definition, justification for smart grids, smart grid conceptual model, smart grid architectures, Interoperability, communication technologies, role of smart grids standards, intelligent grid initiative, national smart grid mission (NSGM) by Govt. of India .TEXT 1 and TEXT 2. Reference Book-1	07	L1,L2,L3.
2	**Smart Transmission Technologies**: Substation automation, Supervisory control and data acquisition (SCADA), energy management system (EMS), phasor measurement units (PMU), Wide area measurement systems (WAMS)TEXT 1 and TEXT 2. Reference Book-1	08	L1,L2,L3.
3	**Smart Distribution Technologies**: Distribution automation, outage management systems, automated meter reading (AMR), automated metering infrastructure (AMI), fault location isolation and service restoration (FLISR), Outage Management Systems (OMS), Energy Storage, Renewable Integration. TEXT 1 and TEXT 2. Reference Book-2	08	L1,L2,L3.
4	**Distributed Generation and Smart Consumption:** Distributed energy resources (DERs), smart appliances, low voltage DC (LVDC) distribution in homes / buildings, home energy management system (HEMS), Net Metering, building to Grid B2G, Vehicle to Grid V2G, Solar to Grid, Micro grid. TEXT 1 and TEXT 2. Reference Book-1	08	L1,L2,L3.
5	**Regulations and Market Models for Smart Grid:** Demand Response, Tariff Design, Time of the day pricing (TOD), Time of use pricing (TOU), Consumer privacy and data protection, consumer engagement etc. Cost benefit analysis of smart grid projects. TEXT 1 and TEXT 2. Reference Book-2	08	L1,L2,L3.

Note 1: Unit 1 to 5 will have internal choice

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.

Note2:

c) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

d) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 1 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes: At the end of the course students will be able to

CO1	Understand technologies for smart grid
CO2	Understand technologies for smart grid.
CO3	Realize the distribution generation and smart consumption.
CO4	Know the regulations and market models for smart grid..

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10	3	3	1	2				2		2		2
2.	CO2	2	10	1	3	1	2				2		2		2
3.	CO3	2	12	2	3	1	2				2		2		2
4.	CO4	4	12	3	3	1	2				2		2		2
5.	CO5	5	8	3	3	1	2				2		2		2
Average Course Outcomes				3	3	1	2				2		2		2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		
CO2		2	
CO3			
CO4			1
CO5	3	2	
Average CO	**3**	**2**	**1**

Text Books.

1 Clark W Gellings, "The Smart Grid, Enabling Energy Efficiency and Demand Side Response", First Edition, CRC Press, 2009

2 Jean Claude Sabonnadière, NouredineHadjsaïd, "The Smart Grid, ", First Edition, Wiely ISTE IEEE Press, 2012

Reference Text Books.

1 JanakaEkanayake, KithsiriLiyanage, Jianzhong. Wu, Akihiko Yokoyama, Nick Jenkins, “. Smart Grid Technology and Applications”, 4th edition, Wiely Publication, 2012

Web Links.

1 https://www.smartgrid.gov/the_smart_grid/smart_grid.html

Subject Title : OOPS using C++

Sub.Code:18EE646 No. of Credits:03=03:0:0 (L - T – P) No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:39

Course Learning Objectives:

1 To understand Object Oriented Programming concepts using the C++ language
2 Introduces the principles of function, classes and objects.
3 Introduces to Constructors, Destructors and Operator overloading.
4 Introduces the principles of inheritance, pointers, virtual functions and polymorphism.
5 Introduces the concept of streams and handling files.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Beginning with C++ and its features:** What is C++? Applications and structure of C++ program, Different Data types, Variables, Different Operators, expressions, operator overloading and control structures in C++ . Topics from Chap-2,3 of Text 1 and Reference Book	07	L1,l2
2	**Functions, classes and Objects:** Functions, Inline function, function overloading, friend and virtual functions, specifying a class, C++ program with a class, arrays within a class, memory allocation to objects, array of objects, members, pointers to members and member functions. Selected Topics from Chap-4,5 of Text1 and Reference Book	08	L1,L2,L3.
3	**Constructors, Destructors and Operator overloading:** Constructors, Multiple constructors in a class, Copy constructor, Dynamic constructor, Destructors, Defining operator overloading, Overloading Unary and binary operators, Manipulation of strings using operators. Selected topics from Chap-6, 7 of Text 1 and Reference Book	08	L1,L2,L3.
4	**Inheritance, Pointers, Virtual Functions, Polymorphism:** Derived Classes, Single, multilevel, multiple inheritance, Pointers to objects and derived classes, this pointer, Virtual and pure virtual functions. Selected topics from Chap-8,9 of Text 1 and Reference Book	08	L1,L2,L3.
5	**Streams and Working with files:** C++ streams and stream classes, formatted and unformatted I/O operations, Output with manipulators, Classes for file stream operations, opening and closing a file, EOF. Selected topics from Chap-10, 11 of Text 1 and Reference Book	08	L1,L2,L3.

Note 1: Unit 1 to 5 will have internal choice

Note2:

a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit and will be delivered by subject faculty.

Course Outcomes:

CO1 Explain the basics of Object Oriented Programming concepts.

CO2 Apply the object initialization and destroy concept using constructors and destructors.

CO3 Apply the concept of run time polymorphism by using virtual functions, overriding functions and abstract class in programs and to implement compile time polymorphism in programs by using overloading methods and operators..

CO4 Use the concept of inheritance to reduce the length of code and evaluate the usefulness..

CO5 Use I/O operations and file streams in programs.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2**	**07**	**3**	**3**	**2**		**2**	**1**		**2**		**2**		**2**
2.	CO2	**3**	**08**	**3**	**3**	**2**		**3**	**1**	**2**	**2**		**2**		**2**
3.	CO3	**2**	**08**	**3**	**3**	**2**		**3**	**1**		**2**		**2**		**2**
4.	CO4	**4**	**08**	**3**	**3**	**2**		**3**	**1**	**2**	**2**		**2**		**2**
5.	CO5	**5**	**08**	**3**	**3**	**2**		**2**	**1**	**2**	**2**		**2**		**2**
Average CO				**3**	**3**	**3**		**3**	**1**	**2**	**2**		**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	3		
CO2		2	
CO3	3		
CO4		2	1
CO5	3	2	
Average CO	3	2	1

Text Books.

1 E. Balaguruswamy, "Object Oriented Programming with C++", 6th Edition, TMH,, 2013

Reference Text Books.

1 Robert Lafore, "Object Oriented Programming using C++", 2nd edition, Galgotia publication, 2010

Web Links.

1 www.nptel.com

Subject Title : POWER SYSTEMS ANALYSIS-2

Sub.Code: 18 EE 71	**No. of Credits:03 = 2:1:0 (L - T – P)**	**No. of Lecture Hours/Week : 04**
Exam Duration:03 Hrs	**CIE + Assignment +Activity +SEE=40+5+5+50=100**	**Total No.of Contact Hours: 52**

Course Learning Objectives:

1. Describe Network Topology and form incidence matrices
2. Formulate Ybus and Zbus matrices for the power system network
3. Analyze the system power flow using different numerical techniques.
4. Evaluate economic operation of power system.
5. Estimate the stability of power system

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Network Matrices:** Introduction, elementary graph theory – oriented graph, tree, co-tree, cut set, loop. Incidence matrices: element-node, bus. Primitive networks – impedance form and admittance form. Formation of Y_{BUS} by method of inspection (including off-nominal tap setting transformer) and by method of singular transformation ($Y_{BUS} = A^T yA$). Formation of bus impedance matrix by step by step building algorithm (numerical problems without mutual coupling elements). *TEXT 2 and Reference Book 3*	11	L1-L4
2	**Load Flow Studies 1:** Introduction, power flow equations, classification of buses, operating constraints and data for load flow. Gauss-Seidal method – formulation of voltage equation, algorithm and flow chart for PQ and PV buses (numerical problems for one iteration only). *TEXT 1,2 and Reference Book 1 &2*	11	L1-L5
3	**Load Flow Studies 2:** Newton-Raphson's method – formulation of power residue equations, evaluation of Jacobian elements. Algorithm and flow chart in polar coordinates (numerical problems for one iteration only). Fast decoupled load flow. Comparison of load flow methods. *TEXT 1,2 and Reference Book 2 & 3*	10	L1-L5
4	**Economic Operation Of Power System:** Introduction, performance curves, economic generation scheduling neglecting losses and generator limits. Economic generation scheduling including generator limits and neglecting losses, iterative techniques. Economic dispatch including transmission losses – approximate penalty factor, iterative technique for solution of economic dispatch with losses. Derivation of transmission loss formula. *TEXT 2 ,3 and Reference Book 3*	11	L1-L5
5	**Transient Stability Studies:** Introduction to power system stability, Numerical solution of swing equation – point-by-point method, modified Euler's method, Milne's Method, Runge-Kutta method. *TEXT 1, 2 Reference Book 1,3*	9	L1-L5

Note 1: Unit 1 to 5 will have internal choice

Note 2: 1. Five assignments are evaluated for 5 marks with one assignment from each unit
2. Group Activity is conducted for 5 Marks

Note 3: 1 Webinar is conducted for some topics and will be delivered by subject faculty.

Course Outcomes:

CO1 Describe the graph theory applied to Power System and construct the fundamental matrices and built the Ybus and Zbus matrices.

CO2 Categorize the buses and formulate the power flow problems of power system network.

CO3 Analyze and solve the power flow problems through different iterative techniques.

CO4 Evaluate the economic operation of power system under various operating conditions..

CO5 Estimate the transient stability of the power system through different numerical methods.

Course Outcomes Mapping with Programme Outcomes and Program specific outcomes

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	1.	2.	3.
CO1.	2	3	3						1		1		1	3		1
CO2.	3	3	3						1		1		1	3		1
CO3.	3	3	3						1		1		1	3		1
CO4.	4	3	3						1		1		1	3		1
CO5.	5	3	3						1		1		1	3		1

Text Books.

1 D. P. Kothari " Modern Power System Analysis", McGraw Hill, 4th Edition,, 2011

2 Stag G. W. and EI-Abiad A. H "**Computer Methods in Power System Analysis**" McGraw Hill International, Student Edition, 1968

3. Haadi Sadat, **Power System Analysis,** TMH, 2nd Edition, 12th reprint, 2002

Reference Text Books.

1 R.N Dhar, "**Computer Aided Power System Operations and Analysis**" Second Edition , TMH, 1984

2 W.D. Stevenson, "Elements of Power System Analysis" 4th Edition , TMH, 4th Edition

3 MA Pai, "**Computer Techniques in Power System**," Second Edition , TMH, 2006

4 K. Uma Rao, "Computer Techniques and Models in Power System" Second Edition , IK International Publishing House Pvt. Ltd, 2008

Web Links.

1 http://www.digimat.in/nptel/courses/video/108107127/L02.html /

2 https://newhorizonindia.edu/nhengineering/computer_aided_power_system_analysis/

3 https://www.youtube.com/watch?v=7voNa0tMb1k&list=PLcwp2fRcIXJWFKh_LrhY2Uu07DqDWPPId

Subject Title: Modern Power System Protection

Sub.Code: 18EE72	**No. of Credits:04=04:0:0 (L - T - P)**	**No. of Lecture Hours/Week : 04**
Exam Duration:03 Hrs	**CIE + Assignment +Activity +SEE=40+5+5+50=100**	**Total No.of Contact Hours:52**

Course Learning Objectives:

1 To introduce conventional and modern protection devices for power systems.
2 To understand the concept and working of Protection devices
3 To learn protection philosophy and understand embedded protection systems.
4 To understand Protection systems through Phasor measurement techniques.
5 To introduce automation concepts and International Standards related to protective relaying.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**e) Fuses:** Introduction to fuse**,** fuse law, cut -off characteristics, time - current characteristics, fuse material, liquid fuse. **f) Circuit Breakers – Operating principles:** Introduction, requirement of a circuit breakers, basic principle of operation of a circuit breaker, properties of arc, initiation and maintenance of arc, arc interruption theories - slepian's theory and energy balance theory**,** **g) Circuit breaker – Types & construction:** SF_6 circuit breaker, puffer and non-puffer type of SF6 breakers. Vacuum circuit breakers - principle of operation and constructional details. Advantages and disadvantages of different types of circuit breakers. TEXT 1 and TEXT 2. Reference 3	10	L1 - L4
2	**b) Protective relaying operating principles:** Requirement of Protective relaying, zones of protection, primary and backup protection, essential qualities of protective relaying, evolution of protective relays – historical perspective, classification of protective relays. A concise introduction to electromechanical relays. **c) Protection philosophies:** Understanding of protection philosophies (the physics of protection) as applicable to the unit protected - such as non-pilot over-current protection of transmission lines, transformer protection, non-pilot distance protection of transmission lines, rotating machinery protection. TEXT 1 and TEXT 2. Reference 3	10	L1 -L4
3	**Embedded protection system:** General architecture & essential requirements of an embedded protection system – metering, protection, automation and control modules; model / component based approach in designing an embedded system; choice of operating system, microprocessor architecture and digital signal processor architecture & requirements of – DMA, ADC, MAC, memory, communication controllers. Reference 1 - 5	12	L1-L4
4	**Phasor measurement, metering and records (DSP techniques):** Definition of a phasor; DSP primer: simultaneity in sampling, sampling theorem, aliasing, digital filters – FIR, IIR, symmetric FIR filters, design of high pass and low pass filters; phasor measurement algorithm; spectral leakage and frequency tracking algorithms. Introduction to synchro-phasor measurement. Reference 1 - 5	12	L1 -L4

5	**Substation automation concepts & communication stacks:** Introduction to substation communication architecture; quasi real time and real time communication requirements; choice of physical layer based on the bandwidth requirements – RS-485, IEEE 802.3. Evolution of communication stacks and standards – MODBUS, IEC 60870-5-103, DNP 3.0, IEC 61850. A brief introduction to MODBUS. A brief introduction to IEC 61850. Reference 1 - 5	08	L1 -L4

Note 1: Unit 1 to 5 will have internal choice

Note 2: 1. Five assignments are evaluated for 5 marks with one assignment from each Unit
2. Group Activity is conducted for 5 Marks

Note 3: Webinar is conducted on a topic and will be delivered by subject faculty.

Course Outcomes:

CO1 Explain protection philosophies, various protection devices and protection schemes

CO2 Analyse the characteristics and applications of various protective devices and protection schemes.

CO3 Apply the basic concepts of protection systems to solve problems related to protection devices and systems.

CO4 Explain and analyse modern protection techniques and systems for application to power system protection.

CO5 Explain automation concepts and justify the use of various international standards related to protective relaying.

Course Outcomes Mapping with Programme Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1.														
1.	2	3	3	2					1				1	3		3
	3	3	3	2					1				1	3		3
	3	3	3	2					1				1		2	
	4	3	3	2		2			1				1		2	
	5						3		1				1		2	

Text Books.

1 *Badri Ram & D.N.Vishwakarma , "Power System Protection and Switch gear", 15th reprint, Tata Mc Graw Hill publication, New Delhi, , 2004*

2 *Soni, Gupta & Bhatnagar , "A Course in Electrical Power", 13th Edition, Dhanapatrai publications,*

Reference Text Books.

1 *Stanley.H.Horowitz & Arun.G.Phadke, "Power system relaying", 3rd edition, Wiley Eastern Publication,*

2 *Arun.G.Phadke & James.S.Thorp, "Computer relaying for power systems", 2 nd edition, Wiley Eastern Publication,*

3 *Bhutanese Oza, et.al , "Power system protection and switchgear", 2 nd edition, Tata Mc Graw Hill publication, New Delhi,*

4 *Y G. Painthankar and S R Bhide , "Fundamentals of Power System protection", 2 nd edition, PHI Learning Private Limited, New Delhi , 2009*

5 *PSRC, W I-01 report, "Applying microprocessor based technology applied to relaying",2009*

Web Links.

https://nptel.ac.in

POWER SYSTEM SIMULATION LABORATORY

Subject Title : **No. of Credits: 1=0:0:1 (L - T – P)** **No. of Lecture Hours/Week : 02**

Sub.Code:18EEL75

Exam Duration:3 Hrs **CIE +SEE=50+50=100** **Total No.of Contact Hours:26**

Course Learning Objectives:

1. Develop skills of using computer packages like MATLAB (coding and SIMULINK) in Power system studies.
2. Develop skills of using Mi-Power package for designing and analysis of electrical power networks, apply and investigate typical case study problems.
3. Develop skills to make use of Virtual lab resources to implement and investigate power system studies.
4. Analyse, the designed power Studies using Open source software MATPOWER to system problems .
5. Develop skills to make use of virtual lab resources for out of class learning

Expt No	MATLAB PROGRAMS	No.of Hours	Blooms Taxnomy level.
1	Using MATLAB, (i) Y-bus formation for power system without mutual coupling by singular transformation & (ii) inspection method.	04	L4
2	Using MATLAB, determination of bus currents, bus power and line flows for a specified system voltage (bus) profile.	02	L4
3	Using MATLAB- power angle Characteristics for (i) salient and (ii) non-salient pole synchronous machines. Determination of reluctance power, excitation emf and regulation.	02	L4
4	Using MATLAB, Optimal generator scheduling for thermal power plants.(2 units & 3 units)	02	L4
5	Using MATLAB- Formation of Jacobian for a system not exceeding four buses (no PV buses)	02	L4
6.	Formation of Z bus using Z bus building algorithm(without mutual coupling)	02	L4
	MiPower Programs		
7.	Using Mi-Power, Optimal generator scheduling for thermal power plants.	02	L4
8.	Using Mi-power, Load flow analysis for (i) three bus (ii) five bus system using Gauss Seidal and Newton Raphson & Fast Decoupled method.	02	L4
9	Using Mi-Power, to determine fault currents and voltages in a given single transmission line system subjected to L-L, L-G, LL-G faults	04	L4
	EXPERIMENT BEYOND SYLLABUS		
10	Using MATPOWER- Fast Decoupled method for Load flow Analysis for the given power system.(3 Bus system only PQ bus)	04	L4

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Develop skills and obtain Power system parameters to experiment with software packages (Matlab/Mi- Power/MAT POWER-open source software) .

CO2 Develop programs and models using computer based tools for analyzing optimal generator scheduling and theoretically to verify the same.
CO3 Develop programs to study different types of faults for stability studies and theoretically to verify the same.
CO4 Analyse Load flow parameters using numerical methods and theoretically for verification.
CO5 Devise programs to analyse and solve real time problems.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	L4	6	3				3							
2.	CO2	L4	5	3				3							
3.	CO3	L4	5	3				3							
4.	CO4	L4	5	3				3							
5.	CO5	L4	5	3				3							
Average CO				3				3							

Course Outcomes with PSOs

Sl.No	CO	PSO1	PSO2	PSO3
1	CO1	3	2	
2	CO2	3	2	
3	CO3	3	2	
4	CO4	3	2	
5	CO5	3	2	
Average CO		3	2	

Text Books.

1 PRDC, "User Manual".2018
2 Nalini S, T B Dayananda, "EEE Department Manual", 2018
3 Desmond J Higham, "MATLAB Guide", Third edition, Manchester,2005

Web Links.

1. http://beta.prdcinfotech.com/power-system-simulator/
2. https://in.mathworks.com/learn/tutorials
3. https://in.mathworks.com/support/learn-with-matlab-tutorials
4. https://www.mathworks.com/matlabcentral/fileexchange/48540-admittance-matrix-formation-y-bus-formation
5. https://www.youtube.com/watch?v=6XMGzJa6HWc
6. https://www.youtube.com/watch?v=SIE-T67Y3-E

Note 1: Programming to be done using MATLAB/MI-Power any versions. Specified Problems shall be done using open source software MAT Power.

Subject Title: PROTECTION AND HIGH VOLTAGE LABORATORY

Sub.Code:18EEL76 **No. of Credits:1=0:0:1 L - T – P)** **No. of Lecture Hours/Week :02**
Exam Duration:3 Hrs **CIE +SEE=50+50=100** **Total No. of Contact Hours:26**

Course Learning Objectives:

1. To study the characteristics of various protection devices.
2. To study the flashover characteristics of air insulation subjected to HVAC and HVDC under uniform and non-uniform field configuration.
3. To study the field distribution in the conductor dielectric medium.
4. To study the generation of standard lightning impulse voltage wave and to evaluate the front and tail times.
5. To measure the high AC and DC voltages using standard sphere gap model

Unit No	Syllabus Contents	No. of Hours	Blooms Taxnomy level.
1	Operating characteristics of non-directional over-current (electro-mechanical) relay.	3	L1, L2
2	IDMT characteristics of over voltage or under voltage relay.(solid state or electromechanical type	3	L1, L2, L3.
3	a) Generation of standard lightning impulse voltage and to determine efficiency and energy of impulse generator. (b) To determine 50% probability flashover voltage for air insulation subjected to impulse voltage.	3	L1, L2, L3,L4
4	Operating characteristics of over voltage or under voltage relay. (Solid state or electromechanical type).	3	L1, L2, L3
5	Current-time characteristics of fuse	3	L1, L2, L3,
6	Operating characteristics of microprocessor based (numeric) over –current relay.	3	L1, L2, L3, L4
7.	Operating characteristics of microprocessor based (numeric) over/under voltage relay.	3	L1, L2, L3, L4
8.	Motor protection scheme-fault studies	3	L1, L2, L3, L4
9	Spark over characteristics of air insulation subjected to high voltage AC, with spark over voltage corrected to STP for uniform and non-uniform field configuration.	3	L1, L2, L3, L4
10	Spark over characteristics of air insulation subjected to high voltage DC for uniform & non-uniform field configurations with spark-over voltage corrected to STP	3	L1, L2, L3, L4
11	Measurement of HVAC and HVDC using standard sphere gap models.	3	L1, L2, L3, L4
12	Breakdown strength of transformer oil using oil-testing unit.	3	L1, L2, L3, L4
13	*Demonstration of: (i)Cascade connection of transformers. (ii) Measurement of partial discharges in underground cables.	3	L1, L2, L3, L4

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Identify the characteristics of protection devices for applications in power system protection.

CO2	Distinguish between the flashover characteristics of air insulation subjected to HVAC and HVDC under uniform and non- uniform field configuration.
CO3	Illustrate the generation of standard lightning impulse voltage wave and to evaluate front and tail times.
CO4	Asses the field strength in liquid insulation and field distribution in the dielectric medium through field plotting.
CO5	To measure the high AC and DC voltages using standard sphere gap model

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10	3	2	2		1		1	1	1	1	1	1
2.	CO2	3	6	3	3	1		1		1	1	1	1	1	1
3.	CO3	2	3	2	3	1		1		1	1	1	1	1	1
4.	CO4	3	3	2	3	1		1		1	1	1	1	1	1
5.	CO5	4	4	3	2	1		1		1	1	1	1	1	1
Average CO				3	3	1		1		1	1		1	1	1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		1
CO2		3	1
CO3	3	1	1
CO4	2	3	
CO5	3	2	
Average CO	**3**	**2**	**1**

Text Books&References

1 Dr.Eranna Dr. S.Vasudevamurthy, "**Department manual-M3**", Second Edition, Choose an item.,

Web Links.

1 Study of Impulse Generator: http://vlabs.iitkgp.ernet.in/vhv/exp1/index.html/ /

2 3 Stage Cockroft Walton's DC voltage multiplier circuit: http://vlabs.iitkgp.ernet.in/vhv/exp10/index.ht

Note 1: 20% program or experiments through virtual lab or any other online platform

Subject Title : COMPUTER AIDED ELECTRICAL DRAWING

Sub.Code: 18EEL78 **No. of Credits:1=0:0:1 (L - T – P)** **No. of Lecture Hours/Week : 02**

Exam Duration:3 Hrs **CIE +SEE=50+50=100** **Total No.of Contact Hours:26**

Course Learning Objectives:

1. Understand the armature and field systems of various electrical machines.
2. Determine pole pitch and winding pitches of armature windings..
3. Illustrate winding diagrams of DC machines..
4. Justify the suitable windings for AC machines.
5. Determine the harmonic reduction in short pitched windings.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Introduction to a) CAD software: Commands to draw line, circle, array, text, mirror, offset, etc….. b) Electrical windings: Armature, field system, pole pitch winding pitch, winding table, developed diagram and sequence diagrams.	1	L1
2	Single layer DC Lap winding.	2	L1-L4
3	Single layer DC Wave windings.	2	L1-L4
4	Double layer Simplex Lap & Wave windings.	2	L1-L5
5	Duplex Lap and wave Windings.	2	L1-L5
6	Equalizer rings and dummy coils	2	L1-L5
7.	Single layer Lap windings of three phase AC machines	2	L1-L5
8.	Single layer Wave of three phase AC machines	2	L1-L5
9	Integral slot double layer Lap and Wave windings	2	L1-L4
10	Short pitched and Fractional slot windings of three phase AC machines	2	L1-L5
11	Hemitropic Un-bifurcated & Bifurcated 2 and 3 tier windings, Mush type windings.	2	L1-L5
12	Transformers: Sectional views of a limb, core type and shell type single phase and three *	2	L1-L5
13	D.C. machine: sectional views of a pole, yoke & field assembly, armature and commutators dealt separately*	2	L1-L5

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcome Choose an item.

CO1 Understand the winding pitches of armature windings of electrical machines.

CO2 Illustrate possible winding pattern for DC machines.

CO3 Demonstrate the possible windings to three phase AC machines.

CO4 Develop the winding pattern to reduce copper usage in the windings.

CO5 Design suitable winding type to reduce or suppress some harmonics.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	2	3	3			3			1		1		1
2.	CO2	3	2	3	3			3			1		1		1
3.	CO3	3	2	3	3			3			1		1		1
4.	CO4	4	2	3	3	2		3			1		1		1
5.	CO5	5	2	3	3	2		3			1		1		1

References Text Books.

1 M. G. Say, "Performance & Design of Alternating Current machines", 3rd Edition, CBS publishers, 2002

2 A.E Clayton & N.N .Hancock "The Performance & Design of DC machines", 3rd Edition, CBS Publication, 2004.

3 A K Sawhney,.4th Edition "Electrical Machine Design"., Dhanapathrai and sons, 2016

4 Dr. Indrani MS, Shankarlal VD & Beaula D,.2nd Edition "CAD for Electrical Engineers", Singuine Technical Publishers, 2015

Web Links.

1 https://www.google.com/search?q=electrical+windings+drawing&rlz=1C1GIWA_enIN736IN736&oq=el&aqs=chrome.0.69i59l3j0j69i57j0l3.25171j0j15&sourceid=chrome&ie=UTF-8

2 https://www.academia.edu/22528348/COMPUTER_AIDED_ELECTRICAL_DRAWING_CAED_10EE65_Winding_Diagrams_i_DC_Winding_diagrams_ii_AC_Winding_Diagrams

3 https://www.google.com/search?rlz=1C1GIWA_enIN736IN736&sxsrf=ALeKk03TO43d1jlsUQy5W0z3ypDLzC72lQ:1596695390727&q=ac+armature+winding+diagram&sa=X&ved=2ahUKEwjSsNDs-YXrAhVezzgGHbGZC3MQ1QIoAXoECAwQAg&cshid=1596695545698918

4 https://www.researchgate.net/publication/241701467_AC_Winding_Analysis_Using_a_Winding_Function_Approach

5 https://www.diva-portal.org/smash/get/diva2:313895/FULLTEXT02.pdf

Note 1: Laboratory report should be submitted to the subject faculty and evaluation should be done on the same week.

Note 2: 20% program or experiments through virtual lab or any other online platform

Subject Title: **SENSORS AND TRANSDUCERS**

Sub.Code: 18EE731 **No. of Credits:03=03:0:0 (L - T – P)** **No. of Lecture Hours/Week : 03**
Exam Duration:03 Hrs **Total No.of Contact Hours:39**

CIE + Assignment +Activity +SEE=40+5+5+50=100

Course Learning Objectives:

1 Understand the use of gauges and transducers to measure pressure, direction, distance and electromagnetic radiations

2 Identify the transducers used for temperature sensing, and for the measurement of sound.

3 Understand the sensors and transducers used for the measurement of mass, volume and environmental quantities.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Strain and Pressure**: Mechanical strain, Interferometry, Fibre optic methods, pressure gauges, low gas pressures, Ionization gauges, Transducer use. **Position, direction, distance, and motion**: Position, Direction, Distance measurement, Distance travelled, Accelerometer systems, Rotation. TEXT 1 and TEXT 2. Reference Book	09	L1,L2,L4
2	**Light and associated radiation**: Nature of light, Colour temperature, Light flux, Photosensors, Photoresistors and photoconductors, Photodiodes, Phototransistors, Photovoltaic devices, Fibre – optic applications, Light transducers, Solid-state transducers, Liquid crystal displays (LCD), Light valves, Image transducers, Radio waves. TEXT 2 and Reference Book	08	L2
3	**Temperature sensors and thermal transducers**: Heat and temperature, The bimetallic strip, Liquid and gas expansion, Thermocouples, Metal – resistance sensors, Thermistors, Radiant heat energy sensing, Pyroelectric detectors, Thermal transducers, Thermal to electrical transducers. TEXT 4 and Reference Book	08	L2
4	**Sound, infrasound and ultrasound:** Principles, Audio electrical sensors and transducers, Electrical to audio transducers. TEXT 3 and Reference Book	07	L2
5	**Solids, liquids and gases**: Mass and volume, Electronic sensors, Proximity detectors, Liquid levels, Liquid flow sensors, Timing, Gases, Viscosity. **Environmental Sensors**: Environmental quantities, Time, Moisture, Acidity/alkalinity, Wind chill, Radioactive count rate, Surveying and security, Animal fat thickness, Water purity, Air purity, Smoke and fire detectors, Building acoustics. TEXT 3 and Reference Book	07	L2

Note 1: Unit 1 to 5 will have internal choice

Note 2: 1. Five assignments are evaluated for 5 marks with one assignment from each Unit
2. Group Activity is conducted for 5 Marks

Note 3: Webinar is conducted on a topic and will be delivered by subject faculty.

Course Outcomes:

CO1	Understand the use of gauges and transducers to measure pressure, direction, position, motion and distance.
CO2	Discuss the use of light transducers and other devices used for the measurement of electromagnetic radiations.
CO3	Understand the working of different temperature sensing devices.
CO4	Summarize the principles and applications of audio electrical sensors and transducers used for the measurement of sound.
CO5	Predict the performance of sensors for the measurement of mass, volume and environmental quantities.

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO6.	2	3	2						1		1			3		1
CO7.	3	3	2						1		1			3		1
CO8.	3	3	2						1		1			3		1
CO9.	4	3	2						1		1			3		1
CO10.	5	3	2						1		1			3		1

Text Books.

1 ***Ian R. Sinclair, "Sensors and Transducers", 3rd Edition, Newnes. 2001.***

Reference Text Books.

1 D. Patranabis, "Sensor & transducers", 2nd Edition., PHI.

1 H.K.P. Neubert, "Instrument transducers", Oxford University press.

Web Links.

1 https://drive.google.com/drive/folders/1qszwDQy_-SOgttLzuvpP5Dy7HrSW3xJT?usp=sharing

1 https://www.electronicshub.org/sensors-and-transducers-introduction/

Subject Title : INSULATION ENGINEERING

Sub.Code: 18EE732 | **No. of Credits:3=3:0:0 (L - T – P)** | **No. of Lecture Hours/Week : 03**

Exam Duration:03 Hrs | **CIE + Assignment +Activity +SEE=40+5+5+50=100** | **Total No.of Contact Hours:39**

Course Learning Objectives:

1. To introduce concepts of dielectric / system, electric stress / stress control and estimation of electric field intensity in dielectric system.
2. To understand the insulation system / s in power system apparatus.
3. To introduce dielectric phenomena and breakdown strength of dielectric media - solid, liquid and vacuum.
4. To understand breakdown processes in gasses, gas insulated substations, surge arrestors and Insulation coordination.
5. To analyse failure of dielectric due to ageing mechanism.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Electrostatic field, their control and estimations:** Electric field intensity, electric strength, classification of electric fields, degree of uniformity of electric fields, control of electric field intensity (stress control), estimation of electric field intensity, basic equations for potential and field intensity in electrostatic fields. TEXT 2 and 4 REFERENCE 1	08	L3
2	**Insulation system in power system apparatus:** Insulation system in capacitors, bushings and transformers. Modes of failure of insulation systems. Insulations used in rotating machines. TEXT 3 and 4, REFERENCE 1	08	L3
3	**Dielectric phenomena:** Dielectric phenomena in insulation – Permittivity and Loss Tangent. Phenomena of polarization, depolarization, relaxation in solids and liquids. Breakdown strengths of dielectric media, influence of type of electrical excitation (AC, DC and Impulse), physics of breakdown phenomena in vacuum gaps. concept of self-restoring and non self – restoring insulation, enclosed and exposed insulation. TEXT 3 and 4, REFERENCE 1	08	L3
4	**Gaseous insulation**: Requirement of gaseous insulation. Breakdown processes: types of collision, elastic and in-elastic, collision cross-section, mobility of ions, diffusion of charges, emission of radiation and excitation, various secondary processes, gas insulated substations. Overvoltage, surge arrestors and insulation coordination. TEXT 2 – 4, REFERENCE 1	08	L3
5	**Ageing phenomena:** Failure of electric insulation due to ageing. Ageing mechanisms - thermal ageing, electrical ageing, combined thermal and electrical ageing. Analysis of insulation failure data, Power law model, graphical estimation of power law constants, ageing data. TEXT 1, REFERENCE 1	07	L4

Note 1: Unit 1 to 5 will have internal choice

Note 2: 1. Five assignments are evaluated for 5 marks with one assignment from each Unit
2. Group Activity is conducted for 5 Marks

Note 3: Webinar is conducted on a topic and will be delivered by subject faculty.

Course Outcomes

CO1 Demonstrate their knowledge on Electric field and analyze electric field problems related to dielectric.

CO2 Explain and analyse - insulation / insulation systems used in power system apparatus.

CO3 Explain dielectric phenomena in insulation and analyse influence of excitations on insulation.

CO4 Explain - breakdown phenomena in gaseous insulation, over voltages in power systems and insulation coordination in power system.

CO5 Demonstrate their knowledge on ageing of insulation and analyse failure of insulation due to ageing.

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	4	3	2		2								1	3		
CO2	4	3	3		2								1	3		2
CO3	4	3	3		2								1	3		2
CO4	4	3	3		2								1	3		2
CO5	4	3	3		3								1	3		2

Text Books.

1 *Hann N.R. Schafer R.E. and Singapore wall N.D. John Wiley and sons, New York, 2002., " Methods of statistical analysis and life data.", , New york, 2002*

2 *E. Kufell and W.S. Zaengl, and J. Kufell, " High voltage Engineering fundamentals.", 2nd edition, Elsevier, 2005*

3 *M.S. Naidu and V Kamaraju,, " High voltage Engineering", 4th edition, TMH, 2008*

4 *Bradwell A. Peter, " Electrical insulation Peregrinus Ltd, London, 1993*

Reference Text Books.

1 Ravindra Arora, Wolfgang Mosch, " High Voltage Insulation Engineering", , New age International Publishers Ltd,

2 J.M. Meek and J.D. Craggs, " Electrical breakdown of gases", Oxford university press, 1953

3 Nasser E. John Wiley Interscience, " Fundamentals of gaseous ionization and plasma electronics", Newyork, 1991

4 M.S. Naidu, " Gas Insulated Substations", I K International Publishing House, 2008

5 Department of High voltage Engineering, Indian Institute of Science, " STTP Lecture notes on Electrical Insulation System Design", Department of High voltage Engineering, Indian Institute of Science, Bengaluru, 1981

Web Links.

https://www.insulation.org

Subject Title : FLEXIBLE A.C. TRANSMISSION SYSTEMS (FACTS)

Sub.Code: 18EE733	**No. of Credits:03=03:0:0 (L- T -P)**	**No. of Lecture Hours/Week : 03**
Exam Duration:03 Hrs	**CIE+Asmt +SEE=40+5+5+50=100**	**Total No.of Contact Hours:39**

Course Learning Objectives:

1. To understand the important parameters which play a vital role in power transmission.
2. To learn the concept of compensations required for a power system and the method of compensations implemented.
3. Emphasize the importance of the voltage and reactive power control in electrical systems
4. State different compensation techniques through FACTS devices
5. Analyse the real and reactive power flow and control in transmission lines using FACTS devices

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**FACTS, Concepts and General System Configuration:** Power Transmission, interconnection, flow of power in ac system, power flow and dynamic stability consideration of a transmission interconnection, relative importance of controllable parameters, and basic types of facts controllers, shunt, series, combined shunt and series connected controllers. TEXT 1 and Reference Book 2	08	L2,L3.
2	**POWER SEMICONDUCTOR DEVICES:** Types of high power devices, principle of high power device characteristics and requirements, power device material, diode, MOSFET, MOS Turn Off Thyristor, Emitter Turn OFF Thyristor, Integrated Gate Commuted Thyristor (GCT & IGCT). TEXT 1 and Reference Book 2	08	L2,L3.
3	**a) VOLTAGE SOURCED CONVERTERS:** Basic concepts, single-phase full wave bridge converter operation, a single-phase bridge converter and 3-phase full wave bridge converter for square wave harmonics. **b) SELF AND LINE COMMUTATED CURRENT SOURCE CONVERTER:** Basic concepts, 3 phase full wave rectifier, thyristor based converter, current sourced converters with turnoff devices, and current source converters versus voltage source converters. TEXT 1 and Reference Book 2	08	L2,L3.
4	**STATIC SHUNT COMPENSATORS SVC AND STATCOM**: Objective of shunt compensation, methods of controllable VAR generation, static VAR compensator, SVC and STATCOM, comparison between SVC and STATCOM. TEXT 1 and Reference Book 2	08	L2,L3.
5	**STATIC SERIES COMPENSATORS:** GCSC, TSSC, TCSC and SSSC, objectives of series compensation, variable impedance type of series compensation, switching converters, types, series compensation, external control for series reactive compensators. TEXT 1 and Reference Book 2	07	L2,L3.

Note1: Unit 1 to 5 will have internal choice

Note2: a)Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4

b) Group Activity for 5 marks has to be evaluated through PPT presentation/ Subject quiz/ Project/ Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1. To understand transmission network of a power system and its peripheral parameters of control.

CO2. To analyse power devices and its characteristics to aid the control of power system parameter.

CO3. To apply different FACTS controllers to control power system.

CO4. To Implement concept of shunt compensation in power system

CO5. To Implement concept of series compensation to power system

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	3	2								1			3		1
CO2	3	2	3	1							1			2	1	1
CO3	4	3	1	1							1			2	1	
CO4	3	3	1	1							1			3	1	
CO5	3	3	1	1							1			3	1	

Text Books.

1 *N.G.Hingorani & Laszlo Gyugyi, "Understanding Facts - Concepts and technology of flexible AC Transmission system", edition IEEE Press, standard publisher, 2001*

Reference Text Books.

1 *S.Rao, "EHV - AC, HVDC Transmission & Distribution Engineering", 3rd edition, Khanna publishers, 2003*

2 *K.R. Padiyar, "FACTS - Controllers in Power Transmission distribution", edition, New age publishers, 2007.*

Web Links.

1 ttps://www.ebooks.com/en-af/book/418812/facts-controllers-in-power-transmission-and-distribution/k-r-padiyar/

2 http://research.iaun.ac.ir/pd/bahador.fani/pdfs/UploadFile_6422.pdf

Subject Title: **POWER SYSTEM OPERATION AND CONTROL**

Sub.Code:18EE741 | **No. of Credits:03=03:0:0 (L - T – P)** | **No. of Lecture Hours/Week : 03**

Exam Duration:03 Hrs | **CIE + Assignment +Activity +SEE=40+5+5+50=100** | **Total No.of Contact Hours:39**

Course Learning Objectives:

1 Impart knowledge relevant to power system planning, operations, components, architecture and configuration of SCADA.
2 Demonstrate an insight into elaborate concepts of Automatic Generation control for Load frequency
3 Evaluate relation between voltage, power and reactive power at a node
4 Define unit commitment and illustrate various constraints in unit commitment and the solution methods.
5 Examine Power system security issues and Contingency analysis.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Control centre operation of power systems: Operating States of Power System, Objectives of Control, Key Concepts of Reliable Operation, Preventive and Emergency Controls Introduction to SCADA, control centre, digital computer configuration, automatic generation control, area control error, operation without central computers, parallel operation of generators. (Problems on parallel operation only) TEXT 1 and TEXT 2. Reference Book	09	L3
2	Automatic Generation Control: Introduction, Load Frequency Control (single area case) Turbine speed governing system Model of speed Governing system, Turbine model, Control area concept, Economic dispatch control, Two area load frequency control, and Automatic voltage regulator. TEXT 2 and Reference Book	08	L3,L4
3	Control of Voltage and reactive power: Introduction, generation and absorption of reactive power, relation between voltage, power and reactive power at a node, Methods of Voltage Control, Dependence of Voltage on Reactive Power , Sensitivity of Voltage to Changes in P And Q single machine infinite bus system, methods of voltage control, sub synchronous resonance, voltage stability, voltage collapse. TEXT 4 and Reference Book	08	L3
4	Unit commitment: statement of the problem, need and importance of Unit commitment, methods – priority list method, dynamic programming method (Flow chart only), constraints, spinning reserve, examples. TEXT 3 and Reference Book	7	L4
5	Power system security: Introduction, system state classification, Security Levels of System, Functions of System Security analysis, factors affecting power system security, modeling for contingency analysis, contingency selection, contingency analysis, Linear sensitivity factors. TEXT 3 and Reference Book	7	L2,L5

Note 1: Unit 1 to 5 will have internal choice

Note 2: 1. Five assignments are evaluated for 5 marks with one assignment from each Unit 2.Group Activity is conducted for 5 Marks

Note 3: Webinar is conducted on a topic and will be delivered by subject faculty.

Course Outcomes:

CO1 Illustrate Economic operation of power system and importance of SCADA

CO2 Analyze the functions of Automatic generation control, speed governors and load frequency control Techniques.

CO3

Ability to analyze methods of voltage and reactive power control

CO4 Solve unit commitment problems.

CO5 Evaluate security issues, contingency analysis, state estimation and related issues of power.

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3						2	1		1			3		2
CO2	2	3						2	1		1			3		2
CO3	4	3						2	1		1			3		2
CO4	5	3						2	1		1			3		2
CO5	3	3						2	1		1			3		2

Text Books.

1 G L Kusic, "Computer aided power system analysis", Second Edition, PHI, 2010.
2 I.J. Nagarath and D.P. Kothari, "Modern Power System Analysis", Second edition, TMH, 2003.
3 AJ Wood &Woolenburg, "Power Generation, Operation & control", 2nd edition, John Wiley & Sons, 2009
4 B.M Weedy and B J Cory, "Electric power Systems", 5th edition, Wiley, 2012. Choose an item.
5 Olle J Elgerd, "Electric Energy Systems", 2nd edition, TMH, 2008

Reference Text Books.

1 PrabhaKundur, "Power System Stability and Control", 3rd edition, TMH, 1993.
2 PSR Murthy, "Operation and control in Power Systems", 2nd edition, B S Publications, 1998.
3 Abhijit Chakraborty, SunitHaldar, "Power system analysis, operation and Control", 2nd edition PHI, 2009
4 K. Uma Rao, "Power System Operation and Control", 1st Edition, Wiley, 2012
5 Robert H Miller & James H Malinowski, "Power System operation", 3rd edition, TMH, 2009

Web Links.

1 https://drive.google.com/drive/folders/1sFUI_GAXgkd0GXPV_UofL-oO4mvZKLK3?usp=sharing

Subject Title : COMPUTER CONTROL OF ELECTRIC DRIVES

Sub.Code:18EE742	**No. of Credits:03=03:0:0 (L - T – P)**	**No. of Lecture Hours/Week : 03**
Exam Duration:03 Hrs	**CIE + Assignment +Activity +SEE= 40+5+5+ 50 = 100 Marks**	**Total No.of Contact Hours:39**

Course Learning Objectives:

1. Introduction to modern digital control of drives, different types of sensors and to study the concept of ac machine drives in detail.
2. To learn phase controlled converters, principles of slip power recovery schemes and to know about principle of Vector Control of AC Drives.
3. To learn about Applications of expert system to Drives.
4. To have knowledge about principle of Vector Control of AC Drives
5. To learn design methodology of drives and fuzzy logic control feedback system.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Review of Micro Controllers in Industrial Drives System**: Typical Micro controller's 8-bit 16-bit (only block diagram) Digital Data Acquisition syste m, voltage sensors, current sensors, frequency sensors and speed sensors TEXT 1 and TEXT 2. Reference Book	08	L1,L2
2	**AC Machine Drives:** Speed control of Induction motors with variable voltage constant frequency, constant voltage variable frequency, V/f constant operation, drive-operating regions. Variable stator current operation. Effect of Harmonics. TEXT 1 and TEXT 2. Reference Book	09	L1,L2,L3.
3	**a) Phase Controlled Converters:** Converter controls, Linear firing angle control, cosine wave crossing control, and phase locked Oscillator principle, Electromagnetic Interference (EMI) and line power quality problems, cyclo converters, voltage fed converters, Rectifiers, and Current fed converters. b) **Principles of Slip Power Recovery Schemes:** Static Kramer's drive system, block schematic diagram, phasor diagram and limitations, Static Scherbins scheme system using D.C link converters with cyclo converter modes of operation, modified Scherbins Drive for variable source, constant frequency (VSCF) generation. TEXT 1 and TEXT 2. Reference Book	08	L1,L2,L3.
4	**Principle of Vector Control of AC Drives:** Phasor diagram, digital Implementation block diagram, Flux vector estimation, indirect vector control block diagram with open loop flux control, synchronous motor control with compensation. TEXT 1 and TEXT 2. Reference Book	08	L1,L2,L3.
5	**Expert System Application to drives (Only Block Diagram):** Expert system shell, Design methodology, ES based P-I tuning of vector controlled drives system, Fuzzy logic control for speed controller in vector control drives, structure of fuzzy control in feedback system. TEXT 1 and TEXT 2. Reference Book	08	L1,L2,L3.

Note 1: Unit 1 to 5 will have internal choice

Note 2: 1. Five assignments are evaluated for 5 marks with one assignment from each Unit 2. Group Activity is conducted for 5 Marks

Note 3: Webinar is conducted on a topic and will be delivered by subject faculty.

Course Outcomes:

CO1 Understand Digital Data Acquisition System and all types of sensors in detail.
CO2 Understand the concept of AC Machine Drives operation and characteristics.
CO3 Analyse different types of phase controlled converters.
CO4 Apply principle of vector control to AC drives.
CO5 Design methodology of drives using fuzzy logic control feedback system.

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	3								2		1	3		
CO2	2	3	3				2				2		1		2	1
CO3	2	3	3				2				2		1	3		
CO4	4	3	3			2					2		1		1	1
CO5	5	3	3	1		2	2				2		1	3	2	

Text Books.

1 Bimal K.Bose, "Power Electronics & Motor Drives", First Edition, Elsevier, 2006
2 Bimal K. Bose, ". Modern Power Electronics & Drives", First edition, Pearson Education, 2003.

Reference Text Books.

1 Badri Ram, "Advanced Microprocessor and Interfacing", 1st Edition, TMH, 2001

Web Links.

1. http://nptel.vtu.ac.in/econtent/courses/EEE/06ES42/index.php

Subject Title : ENERGY AUDITING & DEMAND SIDE MANAGEMENT

Sub.Code: 18 EE 744 **No. of Credits:04=04:0:0 (L - T – P)** **No. of Lecture Hours/Week : 03**
Exam Duration:03 Hrs **CIE + Assignment +Activity +SEE=40+5+5+50=100** **Total No.of Contact Hours:39**

Course Learning Objectives:

1. To enable the students to develop managerial skills regarding energy conservation and energy auditing
2. To facilitate the students to achieve a clear conceptual understanding of energy economic analysis.
3. To recognize opportunities for increasing rational use of energy and basics of energy auditing with application on different sectors.
4. To explain electrical load management techniques, harmonics and their effects, electricity tariffs and power factor improvement
5. To understand the basics of demand side management.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**INTRODUCTION:** Energy Situation – World and India, Energy Consumption, Conservation, Codes, Standards and Legislation. TEXT 4 and TEXT 2. Reference Book	06	L1, L2
2	**Energy Economic Analysis:** The Time Value of Money Concept, Developing Cash Flow Models, Payback Analysis, Depreciation, Taxes and Tax Credit – Numerical Problems. TEXT 4 and TEXT 1. Reference Book	08	L1,L2,L3
3	**Energy Management and Auditing:** Introduction, Definition, Principles of Energy Management, Energy Management Strategy, Elements of Energy Audits, Energy Use Profiles, Measurements in Energy Audits, Presentation of Energy Audit Results. TEXT 4 and TEXT 1. Reference Book-4	08	L1,L2.
4	**Electrical Equipment and power factor**: The Power Triangle, Power Factor, Causes and disadvantages of Low power factor, advantages of High power factor, power factor improvement equipments, calculation of power factor Correction & Location of Capacitors, Energy Efficient Motors, Electrical Tariff, Concept of ABT. TEXT 4 and TEXT 3, Reference Book	09	L1,L2,L3.
5	**Demand Side Management:** Introduction to DSM, Concept of DSM, Benefits of DSM, Different Techniques of DSM – Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning, Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation. Management and Organization of Energy Conservation Awareness Programs. TEXT 4 and TEXT 2. Reference Book-3	08	L1,L2.

Note 1:Unit 1 to 5 will have internal choice

Note 2: Five assignments are evaluated for 5 marks with one assignment from each Unit. Group Activity is conducted for 5 Marks
Note 3: Webinar is conducted on a topic and will be delivered by subject faculty.

Course Outcomes:

CO1 Understand the technology, economics and regulation associated with energy conservation and energy audit.
CO2 Analyse the Energy Economic analysis and develop cash flow models.
CO3 Understand the energy management and methods of energy auditing in energy sector.
CO4 Apply Power factor Correction methods, tariff and ABT for Electric Equipments.
CO5 Familiarize with Demand side management and energy conservation in energy sector.

Course Outcomes Mapping with Programme Outcomes & Programme Specific Outcomes.

Course Out Comes	Level of CO	Program Outcomes												Programme specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3					1	1	1		1			3		1
CO2	2	3						1	1		1			3		1
CO3	2	3						1	1		1			3		1
CO4	4	3						1	1		1			3		1
CO5	5	3						1	1		1			3		1

Text Books.

1 Arry C. White, Philip S. Schmidt, David R. Brown, "Industrial Energy Management Systems", First Edition, Hemisphere Publishing Corporation New York, year
2 Albert Thumann, "Fundamentals of Energy Engineering", edition, Prentice Hall Inc, Englewood Cliffs, New Jersey.
3 A S. Pabla, "Electrical Power distribution", 5th Edition, TMH, 2004
4 Ajjanna, "Energy auditing and demand side management", edition, Gouthami publications,Shimaoga, year

Reference Text Books.

1 D.P.Sen, K.R.Padiyar, IndraneSen, M.A.Pai, "Recent Advances in Control and Management of Energy Systems", Edition, Interline Publisher Bengaluru, 1993

2 Ashok V. Desai, "Energy Demand – Analysis, Management and Conservation", Wiley Eastern, publisher, 2005

3 Jyoti Prakash, "Demand Side Management", Wiley Interscience, TMH publisher, year

4 TERA, "Hand book on Energy Auditing", Tata Energy Research Institute, publisher, year

Web Links.

1 https://drive.google.com/drive/folders/13QKJWlUOdTdPYOhPewyvmO8wKtYQy4IJ?usp=sharing

Panchajanya Vidya Peetha Welfare Trust (Regd)

Dr. Ambedkar Institute of Technology

Aided by Govt. of Karnataka, An Autonomous Institution, Affiliated to Visvesvaraya Technological University, Belagavi, Approved by All India Council for Technical Education (AICTE), New Delhi, Accredited by NBA and NAAC with 'A' Grade

BDA Outer Ring Road, Mallathahalli, Bengaluru - 560 056

Ref. No. ....

Date : 05.01.2022

2020-21

Subjects focusing on Employability/Entrepreneurship/Skill development for the year

S.No	Subject Code	Subject
1.	18EE31	Analog Electronic Circuits
2.	18EE32	Logic Design
3.	18EE33	Network Analysis
4.	18EE34	Transformer and Induction Machines
5.	18EE35	Generation, Transmission & Distribution
6.	18EEL35	Electronic Circuits Lab
7.	18EEL36	Logic Design Lab
8.	18EE41	Electrical & Electronic Measurements and Instruments
9.	18EE42	Control Systems
10.	18EE43	DC Machines and Synchronous Machines
11.	18EE 44	Power Electronics
12.	18EE 45	Linear Integrated Circuits & Applications
13.	18EE L46	Transformer and Induction Machines Lab
14.	18EE L47	Power Electronics Lab
15.	18EE51	Signals and Systems
16.	18EE52	Field Theory
17.	18EE53	Microcontroller
18.	18EE54	Electrical Machine Design
19.	18EEL56	Control Systems Lab
20.	18EEL57	DC Machines and Synchronous Lab
21.	18EE551	Programmable Logic Controllers
22.	18EE552	VLSI Circuits & Design
23.	18EE553	Modern Control Theory
24.	18EE554	Embedded Systems
25.	18EE61	Power System Analysis-I
26.	18EE62	High Voltage Engineering
27.	18EE63	Digital Signal Processing
28.	18EEL65	Digital Signal Processing Lab
29.	18EEL66	Micro controller Lab
30.	18EE642	Special Electrical Machines
31.	18EE643	Artificial Intelligence to Electrical Engineering
32.	18EE644	Electrical Vehicle Technology
33.	18EE645	Smart Grid Technology
34.	18EE646	OOPS with C++
35.	EE71	Computer Techniques in Power System Analysis
36.	EE72	High Voltage Engineering
37.	EEL74	Relay & HV Lab

Ph : 23211232, Fax : 080-23217789, E-mail : principal@dr-ait.org, Website : www.dr-ait.org

38.	EEL75	Power Systems Simulation Laboratory
39.	EEL76	Electrical Drawing
40.	EE731	Flexible AC Transmission Systems(FACTS)
41.	EE732	Energy Auditing & Demand Side Management
42.	EE733	Power Systems Dynamics & Stability
43.	EE734	Fuzzy Logic
44.	EE735	Artificial Neural Network
45.	EE736	Electrical Power Quality
46.	EE81	Modern Power System Protection
47.	EE82	Power System Operation & Control
48.	EE831	Testing & Commissioning of Electrical Equipment
49.	EE832	HVDC Transmission
50.	EE833	Insulation Engineering
51.	EE834	Artificial Intelligence Applications to Power Systems
52.	EE835	Computer Control of Electrical Drives
53.	EE836	Micro & Smart System Technology

BOS Chairman

Principal

Subject Title : Analog Electronic Circuits

Sub.Code: 18EE31 No. of Credits:04=04:0:0 (L - T – P) No. of Lecture Hours/Week: 04
Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:52

Course Learning Objectives:

1 To study the basic concepts of diode circuits such as clippers, clampers and rectifiers

2 To analyze and design of different transistor circuit biasing along with bias stabilization.

3 To study the modelling of transistor and frequency response.

4 To study and to analyze general, feedback and power amplifiers.

5 To study the basics concept of oscillators and FET amplifiers along with characteristics.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Diode Circuits*:*** Diode resistance, diode equivalent circuits, transition and diffusion capacitances, clippers and clampers, rectifiers. TEXT 1 and TEXT 2. Reference Book 1 to 5	10	L1,L2,L3.
2	**Transistor Biasing***:* Operating point, analysis and design of fixed bias circuits, emitter stabilized biased circuits, voltage divider bias, and collector voltage feedback bias. Transistor switching circuits. Bias stabilization: stability factor of different biasing circuits. TEXT 1 and TEXT 2. Reference Book 1 to 5	10	L1,L2,L3.
3	**Transistor Modelling and Frequency Response:** Transistor as two port network, low frequency hybrid model., relation between h– parameter model of CE, CC and CB modes, Millers theorem and its dual. General frequency considerations, low frequency response, miller effect capacitance, high frequency response. TEXT 1 and TEXT 2. Reference Book 1 to 5	10	L1 to L4
4	**a) Multistage Amplifiers:** Cascade and cascade connections, Darlington circuits, analysis and design. **b) Feedback Amplifiers:** Feedback concept, different type of feedback circuits- block diagram approach, analysis of feedback circuits. **c) Power Amplifiers**: Amplifier types, analysis and design of Class A & Class B amplifiers, Harmonic distortion TEXT 1 and TEXT 2. Reference Book 1 to 5	11	L1 to L4
5	**a) Oscillators:** Principle of operation, analysis of phase shift oscillator, Wien bridge oscillator, RF and crystal oscillator. (BJT versions) **b) Field Effect Transistors:** Construction, working and characteristics of JFET and MOSFET. Biasing of JFET. Analysis	11	L1 to L4

	and design of JFET (only common source configuration with fixed bias) TEXT 1 and TEXT 2. Reference Book 1 to 5		

Note 1: Unit 1 to 5 will have internal choice

Note2:
a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 1 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes:

CO1 Recall the basic diode circuits and describe various wave shaping circuits.

CO2 Explain the working of transistor biasing circuits and locate quiescent point.

CO3 Analyze the models of transistor & FET amplifier circuits.

CO4 Design and develop various transistor amplifier circuits.

CO5 Construct and solve the transistor oscillator circuits.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2**	**10**	**3**	**3**	**1**	**3**			**2**	**2**		**1**		**1**
2.	CO2	**2**	**10**	**3**	**3**	**1**	**3**			**2**	**2**		**1**		**1**
3.	CO3	**2**	**12**	**3**	**3**	**1**	**3**			**2**	**2**		**1**		**1**
4.	CO4	**4**	**12**	**3**	**3**	**1**	**3**			**2**	**2**		**1**		**1**
5.	CO5	**5**	**8**	**3**	**3**	**1**	**3**			**2**	**2**		**1**		**1**
Average CO				**3**	**3**	**1**	**3**			**2**	**2**		**1**		**1**

Course Outcomes Mapping with Programme Specific Outcomes

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	3		1
CO2	3		1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", 11th Edition, Pearson Education, 2015.

2 Millman and Halkias, "Electronic Devices and Circuits", 4th Edition, Mc Graw Hill, 2015.

3 David A Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2008.

Reference Text Books.

1 Muhammad Rashid, "Microelectronics Circuits Analysis and Design", 2nd edition, Cengage Learning, 2014

2 B.L. Theraja, A.K. Theraja, "A Text Book of Electrical Technology, Electronic Devices and Circuits", edition, S. Chand Reprint, 2013

3 Anil K. Maini Vasha Agarval, "Electronic Devices and Circuits",1st edition, Wiley publisher, 2009.

4 S.Salivahanan N.Suresh, "Electronic Devices and Circuits",3rd edition, Mc Graw Hill publisher, 2013

5 Thomas L Floyd, "Fundamentals of Analog Circuits", 2nd edition, Pearson publisher, 2012.

Web Links.

1 https://www.electronics-tutorials.ws/

2 https://www.tutorialspoint.com/electronic_circuits/electronic_circuits_introduction.htm

3 https://www.electronicshub.org/tutorials/

4 https://www.allaboutcircuits.com/video-tutorials/

Subject Title : Logic Design

Sub.Code: 18EE32 No. of Credits:03=03:0:0 (L - T – P) No. of Lecture Hours/Week : 03

Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:39

Course Learning Objectives:

1. To provide a comprehensive introduction to fundamentals of digital logic design. Karnaugh Map Techniques, Quine McCluskey and MEV Techniques.
2. To provide an understanding on Karnaugh Map Techniques.
3. To provide an understanding on Quine McCluskey and MEV Techniques.
4. To design and analyze combinational circuits.
5. To design and analyze sequential circuits.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Principles of Combinational Logic-I (Karnaugh maps) - 3, 4 and 5 variables, incompletely specified functions (Don't Care terms), Simplifying Max term equations. TEXT 1 and TEXT 2.	07	L1,L2,L3.
2	Principles of Combinational Logic-II: Limitations of K-Maps, Quine-McCluskey Tabulation Algorithm, Quine-McCluskey using don't care terms, Map entered variables (one and two map variables). TEXT 1 and TEXT 2.	08	L1,L2,L3.
3	Analysis and design of combinational logic – II: Digital multiplexers-using multiplexers as Boolean function generators. Binary adders and subtractors, binary comparators. (1 bit, 2 bits and 4 bits) TEXT 1 and TEXT 2.	08	L1,L2,L3.
4	Sequential Circuits – I: Basic bistable element, Latches - SR latch, master-slave flip-flops (pulse-triggered flip-flops): The master-slave SR flip-flops, master-slave JK flip-flops, edge triggered flip-flops: The positive edge-triggered D flip-flops, negative-edge triggered D flip-flop TEXT 1 and TEXT 2.	08	L1,L2,L3.
5	Sequential Circuits –II: Characteristic equations, registers, counters - binary ripple counters, synchronous binary counters, counters based on shift registers (ring and Johnson), design of a synchronous counters, design of a synchronous mod-6 counter using clocked JK, D, T & SR flip-flops. Sequential Circuit Design - Mealy and Moore models. TEXT 1 and TEXT 2.	08	L1,L2,L5

Note 1: Unit 1 to 5 will have internal choice

Note2: a)Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4

b) Activity for 5 Marks has to be evaluated through PPT presentation/Subject quiz/ Project/ Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 To exemplify the concept of combinational systems using standard gates and minimization methods (Karnaugh Maps up to 5 variables)

CO2 To identify the limitations of K- map and use computerized simplification Techniques (Quine McCluskey tabulation and MEV methods).

CO3 To analyze and design combinational systems composed of standard combinational modules, such as multiplexers, decoders, encoders, adders, subtractors and binary comparators.

CO4 To demonstrate knowledge of simple synchronous sequential systems (flip-flops and latches).

CO5 To analyze and design sequential systems composed of standard sequential modules, such as counters, registers, Mealy and Moore Models.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2**	**08**	**3**	**3**	**1**	**2**						**2**		**2**
2.	CO2	**2**	**11**	**3**	**3**	**1**	**2**						**2**		**2**
3.	CO3	**2**	**12**	**3**	**3**	**1**	**2**						**2**		**2**
4.	CO4	**4**	**10**	**3**	**3**	**1**	**2**						**2**		**2**
5.	CO5	**5**	**11**	**3**	**3**	**1**	**2**						**2**		**2**
Average CO				**3**	**3**	**1**	**2**						**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	1	2	1
CO2	1	2	1
CO3	1	2	
CO4	1	2	1
CO5	1	3	
Average CO	**1**	**2**	**1**

Text Books.

1 John M Yarbrough, "Digital Logic Applications and Design", Third Reprint, Thomson, 2002

2 R D Sudhaker Samuel, "Logic Design", Revised edition, Sanguine Technical Publishers, 2006

Reference Text Books.

1 Charles H Roth, "Fundamentals of logic design", Second edition, Thomson Learning, 2004

2 Mono and Kim, "Logic and computer design Fundamentals", Second edition, Pearson, 2001

Web Links.

1 https://nptel.ac.in/courses/117/105/117105080/

Subject Title : Network Analysis

Sub.Code: 18EE33 No. of Credits:04=03:1:0 (L - T – P) No. of Lecture Hours/Week : 05
Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:65

Course Learning Objectives: This course will enable students to:

1 Describe, Apply and Analyze basic network concepts emphasizing Series and Parallel Combination of Passive Components, Source Transformation and Shifting, Star-Delta Transformation Techniques.

2. Describe, Apply and Analyze use of mesh and nodal techniques for Formulating the Transfer Function of Networks.

3 Apply and Analyze various network theorems in solving the problems related to Electrical Circuits

4 To determine the solution of electrical network using Laplace transformations, Steady state behavior of circuit elements and frequency response in resonant circuits.

5 Describe and Analyze two port networks and methods of analyzing the Electrical Networks..

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Basic Concepts: Practical sources, source transformations, network reduction using star – delta transformation, loop and node analysis with linearly dependent and independent sources for DC and AC networks. Concepts of super node and super mesh. Text 1, Text 2 and Reference Text 1	15	L1,L2,L3.
2	Network Theorems: Superposition theorem, Reciprocity theorem, Thevinin's theorem, Norton's theorem and Maximum Power transfer theorem. Text 1 and Text 2	14	L1,L2,L3.
3	Laplace Transformation & Applications: Solution of networks, step, ramp and impulse responses, waveform Synthesis. Text 2 and Text 3	12	L1,L2,L3.
4	a) Resonant Circuits: Series and parallel resonance, frequency-response of series and parallel circuits, Q factor, bandwidth. b) Transient behaviour and initial conditions: Behaviour of circuit elements under switching condition and their representation, Evaluation of initial and final conditions in RL, RC and RLC circuits for DC excitations. Text 2	11	L1,L2,L3.
5	a) Network Topology: Graph of a network, Concept of tree and co-tree, incidence matrix, tie-set and cut-set schedules, Formulation of equilibrium equations in matrix form, solution of resistive networks and principle of duality. Two port network parameters: Definition and Calculation of z, y, h and ABCD transmission parameters. Modeling with these parameters	13	L1,L2,L3.

	Text 2 and Text 3 and Reference 1		

Note 1: Unit 1 to 5 will have internal choice

Note2: a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4

b) Activity for 5 Marks has to be evaluated through PPT presentation/Subject quiz/ Project/ Seminar.

Note:3 Out of 5 Units, Unit 4 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes: Acquire knowledge for solving problems related to

CO1 Series and Parallel combination of Passive Components, source transformation techniques, Star – Delta Transformation techniques and source shifting techniques

CO2 Network Theorems and Electrical Laws to reduce circuit complexities and to arrive at feasible solutions.

CO3 Analyze the circuit using time and frequency domain.

CO4 Analyze and design resonant circuits.

CO5 Various Two Port Network parameters and their relationship for finding network solutions..

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10		3	1	2				2		2		2
2.	CO2	2	10	3	3	1	2				2		2		2
3.	CO3	2	12	3	3	1	2				2		2		2
4.	CO4	4	12	3	3	1	2				2		2		2
5.	CO5	5	08	3	3	1	2				2		2		2
Average Course Outcomes				**3**	**3**	**1**	**2**				**2**		**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**2**	**1**
CO2	**3**	**2**	**1**
CO3	**3**	**2**	**1**
CO4	**3**	**2**	**1**
CO5	**3**	**2**	**1**
Average PSO	**3**	**2**	**1**

Text Books.

1 Hayt, Kemmerly and Durbin, "**Engineering Circuit Analysis**", 10th Edition, TMH Publication, 2015

2 Roy Choudhury, "**Networks and systems**", 2nd Edition, New Age International Publications, 2016

3 M. E. Van Valkenburg, "**. Network Analysis**",3rd Eedition, PHI publisher, 2009

Reference Text Books.

1 A K Chakraborty, S P Ghosh, "Network Analysis and Synthesis", 1st Edition, TMH publisher, 2009

2 Robert L and Boylestad "Introductory Circuit Analysis", 4TH edition, Pearson publisher, 2010

3 M Nahvi and J A Edminister, "Electric Circuits", 2nd Edition, Schaum's Series , 2002

Web Links.

1 https://www.khanacademy.org/science/electrical-engineering/ee-circuit-analysis-topic, "

2 https://www.circuitlab.com/

3 https://www.youtube.com/watch?v=sqxzQkAdJm0

Subject Title : Transformers and Induction Machines

Sub.Code: 18EE34 No. of Credits:04=04:0:0 (L - T – P) No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:52

Course Learning Objectives:

1. To understand the concepts of transformers, induction machines and their analysis.
2. To evaluate the performance of transformers and induction machines.
3. To analyze the concepts to operate transformers in different configurations and operate in parallel.
4. To understand starters, methods of speed control of induction motor and induction generator.
5. To analyze induction motor with high torque rotors construction.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Basic Concepts: Review of principle of operation, constructional details of shell type and core type single-phase and three-phase transformers, EMF equation, losses and commercial efficiency, condition for maximum efficiency (No question shall be set from the review portion). Concept of ideal transformer, operation of practical power transformer under no load and on load -with phasor diagrams. Equivalent circuit, Open circuit and Short circuit tests, calculation of parameters of equivalent circuit and predetermination of efficiency-commercial and all-day TEXT 1 and TEXT 2. Reference Book	10	L2,L3,L4
2	Transformer continuation: Voltage **r**egulation and its significance. Objects of testing of transformers, polarity test, Sumpner's test. Three-phase Transformers: Introduction, choice between single unit three-phase transformer and bank of single-phase transformers. Transformer connection for three phase operation – star/star, delta/delta, star/delta, delta /star and V/V**.** Phase conversion - Scott connection for three-phase to two-phase conversion. Current inrush in transformers. TEXT 1 and TEXT 2. Reference Book	11	L2,L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
3	Parallel operation (Single-phase & Three-phase): Need, conditions to be satisfied for parallel operation. Load sharing in case of similar and dissimilar transformers. Instrument Transformers: Current transformer and Potential transformer. (c)Three phase Induction Machines: Review of concept of rotating magnetic field. Principle of operation, construction of squirrel-cage, slip-ring induction motor (No question shall be set from the review portion). TEXT 1 and TEXT 2. Reference Book 1	11	L2,L3,L4
4	(a) Characteristic Induction Motor continuation: Slip, torque, torque-slip characteristic. Maximum torque. **p**hasor diagram of induction motor on no-load and on load. Equivalent circuit, losses, efficiency. No-load and blocked rotor tests. Circle diagram and performance evaluation of the motor. Cogging and crawling. (b) Starters & Speed Control of Three-phase Induction Motors: Need for starter. Direct on line (DOL) starters, Star-Delta and autotransformer starting. Rotor resistance starting. Soft (electronic) starters. Speed control - voltage, frequency, and rotor resistance. TEXT 1 and TEXT 2. Reference Book 1	10	L2,L3,L4
5	High torque rotors - Double Cage and deep bar rotor, Equivalent circuit and performance evaluation of double cage induction motor. Induction generator – externally excited and self-excited. Importance of induction generators. (b)Single-phase Induction Motor: Double revolving field theory and principle of operation. Types of single-phase induction motors: split-phase, capacitor start, shaded pole motors. Applications. TEXT 1 and TEXT 2. Reference Book 1	10	L2,L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note2: a)Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4

b) Activity for 5 Marks has to be evaluated through PPT presentation/Subject quiz/ Project/ Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Explain the construction, operation of transformer and induction machines (1-phase and 3-phase).

CO2 Understand the different connections for the three phase operations, advantages and applications.

CO3 Evaluate the performance of transformers and induction machines.

CO4 Analyze induction motors with different rotors and as induction generator.

CO5 Understand the different starters and speed control techniques of three-phase induction motors.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10		3	1	2				2		2		2
2.	CO2	2	10	3	3	1	2				2		2		2
3.	CO3	2	12	3	3	1	2				2		2		2
4.	CO4	4	12	3	3	1	2				2		2		2
5.	CO5	5	08	3	3	1	2				2		2		2
Average Course Outcomes				**3**	**3**	**1**	**2**				**2**		**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	3		1
CO2	3		1
CO3	3		1
CO4	3	2	1
CO5	3		1
Average CO	**3**	**2**	**1**

Text Books.

1 I. J. Nagrath and D. P. Kothari,, “Electric Machines,”, 4th Edition, Tata Mc Graw Hill, 2010

2 B L Theraja, “Electrical technology-AC & DC Machines”, 2 Vol, S Chand Publishers, 2012

Reference Text Books.

1 M. G. Say, “Performance and Design of A.C. Machines”, 3rd Edition, C.B.S Publishers, 2002

2 Kosow, “Electrical Machines and Transformers”, 2nd edition, Pearson, 2007

3 Alexander Langsdorf, “Theory of Alternating Current Machines”, 2nd edition, T.M.H, 2001

4 M.V Bhakshi, “Transformer and Induction Machine”, 3rd Edition, Technical Publisher, 2009

5 Robert M. Del Vecchi, “Transformer Design Principles”, 3rd Edition, CRC PRESS, 2017

Web Links.

1 https://www.electrical4u.com/electric-machines/

2 www.transformertechnologies.com

3 https://en.wikipedia.org/wiki/Hyperlink

Subject Title : Generation, Transmission and Distribution

Sub.Code: 18EE35	No. of Credits: 3; L:T:P- 3:0:0	No. of Lecture Hours/Week: 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 To introduce the concepts and various sources for power generation

2 To describe the overhead and underground transmission systems.

3 To understand the concepts of insulators, corona and distribution systems

4 To evaluate the line parameters of transmission systems

5 To analyze the performance of power transmission lines

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**a) Generation:** Sources of electrical power: General arrangement & working of nuclear, thermal and hydro power plant (block diagram approach only) , nuclear power plant - site selection, pros and cons, thermal power plant – site selection, pros and cons, hydro power plant, site selection, pros and cons. **b) Introduction to typical transmission and distribution systems:** General layout of power system, Standard voltages for transmission, advantages and limitation of AC transmission system. TEXT 1 and TEXT 2. Reference Book 1 & 2	07	L1,L2 & L3
2	**Overhead Transmission Lines**: Types of supporting structures and line conducting materials used. Sag calculation- supports at same level and at different levels. Effect of wind and ice, Sag at erection, Stringing chart and sag templates. Line vibration dampers. TEXT 1 and TEXT 2. Reference Book 1 & 2	08	L1,L2,L4
3	**a) Line parameters:** Calculation of inductance of single phase line, three phase line with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Capacitance of single phase line, three phase line with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. **b) Performance of Power Transmission Lines:** Short transmission lines, medium transmission lines- nominal T, End condenser and π models, long transmission lines, ABCD constants of transmission lines, Ferranti effect, line regulation. TEXT 1 and TEXT 2. Reference Book 2 & 3	08	L1,L2,L3,L4
4	**a) Insulators**: Introduction, classification, potential distribution over a string of suspension insulators. String	08	L2,L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	efficiency & methods of improving string efficiency - grading rings and arcing horns. **b) Corona:** Phenomena, disruptive and visual critical voltages, corona power loss, illustrative examples. Advantages and disadvantages of corona. TEXT 1 and TEXT 2. Reference Book 1 & 3		
5	**a) Underground Cables:** Types, material used, insulation resistance, charging current, grading of cables - capacitance grading & inter sheath grading, testing of cables. **b) Distribution systems:** Requirements of power distribution, radial & ring main systems, AC and DC distribution - Calculation for concentrated loads and uniform loading, illustrative examples. TEXT 1 and TEXT 2. Reference Book 2 & 3	8	L2,L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5 and Group Activity for 5 Marks

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Explain the different methods of Power generation concepts using renewable and non – renewable sources and typical transmission scheme and voltage levels
CO2	Describe the mechanical design calculations, different types of line insulators and the concept of Corona, formation, its influence on the operation of overhead transmission lines.
CO3	Apply the acquired knowledge of transmission and distribution systems, analyze the DC & AC distributors with different types of loads and analyse the working of underground Cables.
CO4	Apply the acquired knowledge to evaluate line parameters of 1-Φ and 3- Φ transmission and distribution systems.
CO5	Analyze the performance of power transmission lines by evaluating the line regulation and efficiency.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**1,2,3**	**10**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
2.	CO2	**1,2,4**	**10**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
3.	CO3	**1,2,3,4**	**12**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
4.	CO4	**2,3,4**	**12**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
5.	CO5	**2,3,4**	**8**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
Average COs				**3**	**3**	**1**	**2**				**2**		**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	1	1
CO2	3	1	1
CO3	3	1	1
CO4	3	1	1
CO5	3	1	1
Average CO	**3**	**1**	**1**

Text Books.

1 S. M. Singh, "Electric Power Generation, Transmission and Distribution", Second Edition, PHI Publisher, 2009

2 Soni Gupta & Bhatnagar, Dhanpat Rai & Sons, "A Course in Electrical Power", Third Edition, Dhanpat Rai & Sons Publisher, 2010

Reference Text Books.

1 W.D. Stevenson, "Elements of Power System Analysis", Fourth Edition, TMH publisher, 2017

2 Dr. S. L. Uppal, "Electrical Power Systems", Fifteenth Edition, Khanna Publications publisher, 1987

3 C. L. Wadhwa, "Electrical Power Systems", Sixth Edition, New Age International Publisher, 2010

Web Links.

1 https://nptel.ac.in/courses/108/102/108102047/

2 https://www.smartzworld.com/notes/transmission-and-distribution-pdf-vtu-td/

Subject Title : Electronic Circuits Lab

Sub.Code: 18EEL36 No. of Credits:1=0:0:1 (L - T – P) No. of Lecture Hours/Week : 02
Exam Duration:3 Hrs CIE +SEE=50+50=100 Total No.of Contact Hours:26

Course Learning Objectives:

1. To introduce the electronic components and devises to identify, read their ratings, tolerance operations etc.,
2. Design resonant circuits to resonate at required frequencies.
3. Design resonant circuits to resonate at required frequencies..
4. Design and test various amplifier circuits..
5. Construct and verify various circuits to oscillate at specified frequency

Expt No	Expertiment Contents	No.of Hours	Blooms Taxnomy level.
	Introduction: Use of bread board, CRO, power supplies, signal generators, DRBs, DIBs, DCBs; color codes, resistors, inductors, capacitors, rheostats, multimeters; transistors, diodes; device data sheets.	2	L1-L4
1	**Clipping Circuits**: Design and testing of diode shunt, series and peak detection clippers	2	L1-L4
2	**Clamping Circuits**: Design and testing of diode clamping circuits.	2	L1-L4
3	**Rectifier Circuits**: Testing of half wave, full wave and bridge diode rectifiers with and without capacitor filter, determination of ripple factor, regulation and efficiency.	2	L1-L5
4	**Resonant Circuits:** Characteristics of series and parallel resonant circuits.	2	L1-L5
5	**Transistor Static Characteristics:** CE, CB and CC modes and determination of h parameters.	2	L1-L5
6	**RC Coupled Amplifier:** Design of single stage BJT amplifier and determination of the gain-frequency response, input and output impedances.	2	L1-L5
7.	**Darlington Emitter Follower:** Design of BJT Darlington emitter follower circuit and determination of the gain, input and output impedances.	2	L1-L5
8.	**RC Phase Shift Oscillator**: Design and testing for the performance of BJT-RC Phase shift oscillator for a frequency, $f_0 \leq 10$ kHz	2	L1-L4

Expt No	Experiment Contents	No.of Hours	Blooms Taxnomy level.
9	**Tuned Oscillators:** Design and testing of the performance of BJT-RC Hartley and Colpitt's oscillator for frequency, $f_0 \geq 100$ kHz	2	L1-L5
10	**Crystal Oscillator:** Design and testing of BJT -crystal oscillator for $f_0 > 1$ MHz	2	L1-L5
	Experiments beyond the Syllabus		
1	**Cascade Amplifier:** Design of RC coupled two stage amplifier and determination of the gain-frequency response, input and output impedances.	2	L1-L5
2	**Push Pull Amplifier:** Design and testing of class B push pull power amplifier.	2	L1-L5

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcome.

- CO1 Explain the working of diode wave shaping circuits and to draw transfer characteristics.
- CO2 Evaluate the characteristics of BJTs
- CO3 Test the resonant circuits resonating at required frequency.
- CO4 Design of amplifier circuit, draw frequency response and determine input and output impedances
- CO5 Construct and test transistor circuits to oscillate at desired frequencies.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2**	**2**	**3**	**3**			**1**	**1**					**2**	**2**
2.	CO2	**2**	**2**	**3**	**3**	1		**1**			**1**			**2**	**2**
3.	CO3	**2**	**3**	**3**	**3**	1		**1**		**1**				**2**	**2**
4.	CO4	**4**	**3**	**3**	**3**	1		**1**						**2**	**2**
5.	CO5	**5**	**3**	**3**	**3**	1		**1**	**1**					**2**	**2**
Average CO				3	3	1		1	1	1	1	1		2	2

Course outcomes Mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3		2	1
CO4	3		1
CO5	3	2	

Average CO	3	2	1

References Text Books.

1 Robert L. Boylestad and Louis Nashelsky, ‘Electronic Devices and Circuit Theory’, PHI/Pearson Education. 9TH Edition,2010

2 Departmental Laboratory Manual

Web Links.

1 http://vlabs.iitb.ac.in/vlabs-dev/labs/analog-electronics/experiments/wein-bridge-oscillator-iitr/

2 http://vlabs.iitb.ac.in/vlabs-dev/labs/analog-electronics/experimentlist.html

Subject Title : Logic Design Lab

Sub.Code: 18EEL36 No. of Credits:1=0:0:1 (L - T – P) No. of Lecture Hours/Week : 02
Exam Duration:3 Hrs CIE +SEE=50+50=100 Total No.of Contact Hours:26

Course Learning Objectives:

1 Introduction to digital electronics lab- nomenclature of digital ICs, specifications, study of the data sheet, concept of Vcc and ground, verification of the truth tables of logic gates using ICs.

2 Implementation of the given Boolean function using logic gates in both SOP and POS forms.

3 Verification of state tables of SR, JK, T and D flip-flops using ICs.

4 Implementation and verification of Decoder and Encoder using logic gates.

5 Design and verify the 4-bit synchronous counter.

Expt No	Experiment Contents	No.of Hours	Blooms Taxnomy level.
1	Realization of half / full Adder and half/full Subtractors using Logic gates	2	L1, L2
2	.i) Realization of parallel adder/Subtractors using 7483 chip (ii) BCD to Excess-3 code conversion and vice versa.	2	L1,L2,L3
3	Realization of Binary to Gray code converter and vice versa.	2	L1, L2, L3,L4
4	Design and Testing of 555 Timer	2	L1, L2, L3, L4
5	Realization of One / Two bit comparator & study of 7485 magnitude comparator.	2	L1, L2, L3, L4
6	MUX / DEMUX use of 74153, 74139 for arithmetic circuits and code conversion	2	L1, L2, L3, L4
7.	Design and realization of 4 bit magnitude comparator using IC 7485.	2	L1, L2, L3, L4
8.	Use of a) Decoder chip to drive LED/LCD Display and b) Priority encoder	2	L1, L2, L3, L4
9	Truth table verification of flip-flops: 1) J-K Master Slave 2) T-Type 3) D-Type	2	L1, L2, L3, L4
10	Shift left, Shift right, SIPO,SISO, PISO, PIPO operations using IC 7495S	2	L1, L2, L3, L5
	Experiments beyond the Syllabus		
1	Realization of 3 bit counters as a sequential circuit using	2	L1,l2
2	Design and Testing o Ring and Johnson counters using IC7495, IC7490, IC74193	2	L1,l2

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Apply the concept of various ICs, Logic gates and other components used in Digital logic circuit design.

CO2 Solve K-Maps and realize Boolean expressions.

CO3 Design and implement various code converters.

CO4 Design and implement combinational circuits for various digital applications.

CO5 Design and implement sequential circuits.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	**2**	**5**	**3**	**3**	**3**		**3**				**3**	**3**		**3**
2.	CO2:	**3**	**5**	**3**	**3**	**2**		**3**				**2**	**3**		**3**
3.	CO3:	**5**	**5**	**2**	**2**	**2**		**2**				**2**	**2**		**2**
4.	CO4:	**5**	**5**	**3**	**2**	**3**		**2**				**3**	**2**		**2**
5.	CO5:	**5**	**4**	**3**	**3**	**3**		**2**				**3**	**3**		**3**
Average CO				**3**	**3**	**3**		**2**				**3**	**3**		**3**

Course outcomes Mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1		2	
CO2	2	2	2
CO3		2	
CO4		2	
CO5		2	
Average CO	**2**	**2**	**2**

References Text Books.

1 K A Krishnamurthy, "Digital Lab Primer", Reprint Edition, Pearson Education Asia Publications , 2003

2 Departmental Lab Manual

Web links.

1. **State Diagram:** https://cse15-iiith.vlabs.ac.in/exp10/Introduction.html?domain=Computer%20Science&lab=DLD%20Lab
2. **ALU with function:** https://cse15-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Computer%20Science&lab=DLD%20Lab

Subject Title : Electrical and Electronic Measurements and Instruments

Sub.Code: 18EE41	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 Understand the errors encountered in measuring instruments.

2 Derive the balance conditions in AC and DC bridges for the measurement L, C, R and dissipation factor etc.

3 To analyse the working of analogue and digital measuring instruments, and determine the necessary conditions for working of instrument transformers.

4 To analyse the working principles of signal generators used in the laboratories

5 To distinguish and describe various transducers and display devices used in instrumentation.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Measurement of Power, Energy, Power factor and Frequency:** Dynamometer wattmeter construction and working principle UPF and LPF wattmeters. Measurements of real and reactive power in 3 phase circuits. Induction type energy meter construction and operation. Construction and operation of single-phase and three phase dynamometer type power factor meter. Weston frequency meter and phase sequence indicator. TEXT 1 and TEXT 2. Reference Book 1 to 3	08	L1-L4
2	**a) Measurement Errors:** Definition of error, Gross errors and systematic errors, Absolute and relative errors, Accuracy, Precision, Resolution and Significant figures. **b) Digital Instruments:** Introduction, digital voltmeters (DVM) of ramp type, successive approximation principles, resolution and sensitivity, general specifications, Digital Multimeters. ADC and DAC. Digital frequency meters. TEXT 1 and TEXT 2. Reference Book1 to 3	08	L1-L3.
3	**Bridges:** Wheatstone's bridge, Kelvin Bridge; AC bridges - Capacitance Comparison Bridge, Maxwell's bridge, Wein's bridge, Schering bridge, D'sautys bridge, Wagner's earth connection, examples. TEXT 1 and TEXT 2. Reference Book 1 to 3	07	L1-L4
4	**a) Measuring Instruments (AC and DC):** Introduction, ammeter, voltmeter, Multi-range voltmeter, extending voltmeter range. AC voltmeter using Rectifiers – Half wave and full wave, Peak responding and True RMS voltmeters, ammeters, multimeters.	08	L1-L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	b) Instrument Transformers: Construction and theory of instrument transformers, ratio and phase angle errors of C.T. and P.T. including derivation and Numerical problems. TEXT 1 and TEXT 2. Reference Book 1 to 3		
5	**a) Signal Generators and Analyzers:** Introduction, Fixed and variable AF oscillator, standard signal generator, laboratory type signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator, Sweep frequency generator. **b) Display Devices:** Digital display system, classification of display, Display devices, LEDs, LCD, Analog and Digital storage oscilloscope. TEXT 1 and TEXT 2. Reference Book 1 to 3	08	L1-L3.

Note 1: Unit 1 to 5 will have internal choice

Note2:
a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 4 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes:

CO1 Explain the working of various meters used for measurement of Power, Energy & understand the adjustments, calibration & errors in energy meters.

CO2 Understand the different measurement errors and analyse different digital instruments and their working.

CO3 Measure resistance, inductance and capacitance using bridges and determine earth resistance

CO4 Assess the performance of different measuring instruments.

CO5 Analyze and interpret different signal generator circuits for the generation of various waveforms and also to understand the use of different display devices.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**4**	**8**	**3**	**3**	**1**	**2**				**1**	**1**	**1**		**1**
2.	CO2	**3**	**8**	**3**	**3**	**1**					**1**	**1**	**1**		**1**
3.	CO3	**3**	**7**	**3**	**3**	**1**	**2**				**1**	**1**	**1**		**1**
4.	CO4	**4**	**8**	**3**	**3**	**1**	**2**				**1**	**1**	**1**		**1**
5.	CO5	**3**	**8**	**3**	**3**	**1**					**1**	**1**	**1**		**1**
Average CO				**3**	**3**	**1**	**2**				**1**	**1**	**1**		**1**

Course Outcomes Mapping with Programme Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 A.K. Sawhney, "Electrical and electronic Measurements and Instrumentation", 10th Edition, Dhanpat Rai and Co, 2015

2 R K Rajput, "Electrical and Electronic Measurements and Instruments", 3rd edition, S Chand, 2013

Reference Text Books.

1 J. B. Gupta, "A Course in Electronics and Electrical Measurements and Instrumentation", 13th edition, Katson Books, 2008

2 David A Bell, "Electronic Instrumentation and Measurements", 2nd Edition, PHI, 2006

3 Cooper D & A D Helfrick, "Modern electronic instrumentation and measuring techniques", edition, PHI, 1998

Web Links.

1 https://lecturenotes.in/subject/64/electrical-and-electronics-measurement

2 https://www.academia.edu/8140873/A_K_Sawhney_A_course_in_Electrical_and_Electronic_Measurements_and_Instrumentation

3 https://www.pdfdrive.com/an-introduction-to-electrical-instrumentation-and-measurement-systems-a-guide-to-the-use-selection-and-limitations-of-electrical-instruments-and-measurement-systems-e158029348.html

Subject Title : CONTROL SYSTEMS

Sub.Code: 18EE42	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives: The students should be able to

1 Learn the type of System, dynamics of physical systems, classification of control system, analysis and design objective

2 Represent system by transfer function and block diagram reduction method and Mason's gain formula

3 Learn time response analysis and demonstrate their knowledge to frequency response.

4 Learn stability analysis of system using Root locus, bode plot and Nyquist plot.

5 Learn the concept of Lag/Lead Compensator

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**a) Introduction to control system**: Types of Control Systems – Effect of Feedback Systems, Differential equation of Physical Systems – Mechanical Systems, Electrical Systems, Analogous Systems. Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs. Introduction to P, PI and PID controllers (Excluding Design). b) **Servomotor:** transfer functions, applications. TEXT 1 and Reference Book-2	10	L1,L2,L3.
2	**Time Response of feedback control systems:** Standard test signals, Unit step response of first and second order systems, Time response specifications, Time response specifications of second order systems, steady state errors and error constants. TEXT 1 and Reference Book-2	10	L1,L2,L3.
3	a) **Stability analysis:** Concepts of stability, Necessary conditions for stability, Routh- stability criterion, Relative stability analysis. b) **Root Locus Techniques:** Introduction, root locus concepts, Construction of root loci and stability studies. TEXT 1 and Reference Book-2	12	L1,L2,L3.
4	a) **Frequency domain analysis:** Introduction, Correlation between time and frequency response, bode plots, all pass and minimum phase systems, Assessment of relative stability using Bode Plots, Experimental determination of Transfer function. b) Lag and lead compensators. TEXT 1 and Reference Book-1	10	L1,L2,L3.
5	**Stability in the frequency domain:** Mathematical preliminaries, Nyquist stability criterion (Inverse polar plots	10	L1,L2,L3.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	excluded), Assessment of relative stability using Nyquist criterion (systems with transportation lag excluded). TEXT 1 and Reference Book-1		

Note 1: Unit 1 to 5 will have internal choice

Note2:

c) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

d) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 3 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes: At the end of the course students will be able to

CO1	Demonstrate an understanding of the fundamentals of control systems.
CO2	Develop the mathematical model of the physical systems.
CO3	Analyze the response of the closed and open loop systems.
CO4	Analyze the stability of the closed and open loop systems using Root locus and Bode plot techniques.
CO5	Design the various kinds of compensator

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				a	b	c	d	e	f	g	h	i	j	k	l
1.	CO1	**2**	**10**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
2.	CO2	**2**	**10**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
3.	CO3	**2**	**12**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
4.	CO4	**4**	**12**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
5.	CO5	**5**	**8**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
Average Course Outcomes				**3**	**3**	**1**	**2**				**2**		**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	1
Average CO	3	2	1

Text Books.

1 J. Nagarath and M.Gopal, “Control Systems”, First Edition, Spectrum Publisher, 2008

Reference Text Books.

1 K. Ogata, “. Modern Control Engineering”, 4th edition, Pearson Education Asia/PHI, 2002

2 P. S. Satyanarayana, “Concepts of Control Systems”, 1st edition, Dynaram publishers, 2001

3 M. Gopal, “Control Systems – Principles and Design”, 2nd edition, TMH, 1999

4 J. J. D’Azzo and C. H. Houpis, “. Feedback Control System Analysis And Synthesis”, 5th edition, McGraw Hill, 2010

5 Enter name, “Book title”, edition, publisher, year

Web Links.

1 http://ctms.engin.umich.edu/CTMS/index.php?aux=Home ;Control Tutorials for MATLAB and Simulink

2 https://www.youtube.com/user/ControlLectures/

Subject Title : DC MACHINES AND SYNCHRONOUS MACHINES

Sub.Code: 18EE43	No. of Credits:04=4:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1	To gain knowledge on construction and working of DC machines and synchronous machines
2	To analyze characteristics of DC machines and synchronous machines
3	To evaluate various methods of testing, losses and efficiency of DC machines.
4	To analyze various methods of determining voltage regulation of a synchronous generator.
5	To analyze the operation of a synchronous machine (both as a generator and motor).

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**DC Generator**: Classification of DC generator, types of armature winding, emf equation, no-load characteristic, armature reaction, load characteristics. Commutation, types of commutation, commutation difficulties, interpoles, compensating winding and equalizer rings (only qualitative treatment). Classification of DC motors, back emf and its significance, torque equation, characteristics of shunt, series & compound motors, speed control of shunt and series motors. Application of DC motors. TEXT 1 and TEXT 2. Reference Book. 1 & 2	10	L1,L2
2	**Losses and efficiency:** Losses in dc machines, power flow diagram, efficiency, condition for maximum efficiency. **Testing of dc machines**: Direct & indirect methods of testing of DC machines-brake test, swine burn’s test, Hopkinson’s test, retardation test, field’s test, merits and demerits of tests. TEXT 1 and TEXT 2. Reference Book. 1 & 2	10	L2,L3
3	**Synchronous machines:** Principle of operation, construction of salient & non-salient pole synchronous machines, generated emf, effect of distribution and chording of winding, harmonics-causes, reduction and elimination. Armature reaction, synchronous reactance, leakage reactance, phasor diagram of non-salient type alternator. TEXT 1 and TEXT 2. Reference Book. 2 & 3	10	L3,L4
4	**Voltage Regulation**: Voltage regulation by EMF, MMF, ZPF & ASA method. Short circuit ratio and its importance. Two reaction theory-direct and quadrature axis reactance, phasor diagram. Slip test and regulation.	12	L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	Synchronizing to infinite bus bars, parallel operation of alternators. Operating characteristics, power angle characteristics excluding armature resistance, operation for fixed input and variable excitation. TEXT 1 and TEXT 2. Reference Book: 4		
5	**Synchronous motor:** Principle of operation, phasor diagrams, torque and torque angle, effect of change in load, effect of change in excitation, 'V' and 'inverted V curves'. Synchronous condenser, hunting and damping. Methods of starting of synchronous motors. **Special DC motors**: Permanent magnet motors, brushless DC motors. Applications. TEXT 1 and TEXT 2. Reference Book 4	10	L4,L5

Note 1: Unit 1 to 5 will have internal choice

Note2:
e) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
f) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes:

CO1 Explain phenomena related to DC, synchronous machines and special machines.

CO2 Explain the operation, characteristics and performance of DC, synchronous machines and special machines.

CO3 Solve problems related to speed control, losses and efficiency of DC machines.

CO4 Analyze the behaviour of synchronous machines in parallel and on infinite bus bars.

CO5 Evaluate voltage regulation of synchronous generators by various methods.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**1**	**10**	**3**	**2**		**1**			**1**			**1**		**2**
2.	CO2	**2**	**10**	**3**	**2**		**1**			**1**			**1**		**2**
3.	CO3	**3**	**10**	**3**	**2**		**1**			**1**			**1**		**2**
4.	CO4	**4**	**12**	**3**	**2**		**1**			**1**			**1**		**2**
5.	CO5	**5**	**10**	**3**	**2**		**1**			**1**			**1**		**2**
Average CO				**3**	**2**		**1**			**1**			**1**		**2**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	1
Average CO	3	2	1

Text Books.

1 DP Kothari, I.J.Nagarath, "Electrical Machinery", Fourth Edition, TMH, 2010

2 P.S Bhimbra, "Electrical Machines", Seventh Edition, Khanna Publishers, year

3 AshfaqHussain, DhanpatRai, "Electrical Machines", edition, DhanpatRai Publications, year

Reference Text Books.

1 M. G. Say, "Performance& Design of Alternating Current machines", Third Edition , CBS publishers, 2002

2 A.E Clayton & N.N.Hancock e, "The Performance & Design of DC machines", Third edition CBS Publication, 2004

3 Mulukuntla.S.Sarma, "Electric Machines", First edition, Cengage Learning, 2009

4 Ahhijit Chakrabarti, SudiptaBebnath, "Electric Machines", Electrical Machines Kindle Edition, McGraw Hill Education (India) Private Limited, year

Web Links.

1 https://nptel.ac.in/courses/108/102/108102146/

2 http://nptel.vtu.ac.in/econtent/courses/EEE/10EE54/index.php

3 https://nptel.ac.in/courses/108/105/108105017/

Subject Title : POWER ELECTRONICS

Sub.Code: 18EE44 No. of Credits:04=04:0:0 (L - T – P) No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:52

Course Learning Objectives:

1. Understand various power semiconductor devices, characteristics and their applications
2. Study different methods of triggering power semiconductor devices
3. Learn different power electronics converters with modes of operation
4. Analyze the performance of different power converter circuits for electric drives
5. Apply different methods of speed control of Electric motors

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Introduction to Power Semiconductor Devices:** Power semiconductor devices, applications. Thyristor types, SCR structure – static characteristics, switching characteristics of SCR, MOSFET and IGBT, ratings, two transistor model, di/dt and dv/dt protection. Firing circuits using UJT and digital ICs. Isolation of control & power circuit. TEXT 1 and TEXT 2. Reference Book 1	10	L1,L2,L3.
2	**Controlled Rectifiers:** Principle of phase controlled converter operation. Single-phase and three-phase converters – half, semi and full bridge converters with R & RL load. TEXT 1 and TEXT 2. Reference Book	10	L1,L2,L3.
3	**DC Choppers:** Introduction to commutation, Chopper classification, Performance parameters, control strategies, Principle of step-down and step-up chopper with R & R-L load. DC motor (Separately, Shunt & Series) Speed control, open loop and closed loop transfer function for separately excited motor -four quadrant operation of DC drive. TEXT 1 and TEXT 2. Reference Book 2	10	L1,L2,L3.
4	**a) AC Voltage Controllers:** Principle of ON-OFF and phase control with R and RL load. Single-phase bidirectional controllers with resistive and inductive loads. **b) Inverters:** Inverter classification**,** Principle of operation of basic half bridge inverter and full bridge inverter, Performance parameters. Three-phase bridge inverter-120^0 and 180^0mode of operation. TEXT 1 and TEXT 3. Reference Book1	12	L2,L3,L4
5	**Control of AC Drives:** Basic Induction Motor Equations, speed control of squirrel cage induction motor by voltage source inverter- stator voltage control, variable frequency control. Rotor resistance control and Slip power recovery scheme.	10	L1,L2,L3.

	TEXT 1 and TEXT 3.Reference Book1		

Note 1: Unit 1 to 5 will have internal choice

Note2: a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5 .

b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 4is a Webinar unit conducted through Google Classroom/ Zoom/Cisco-Webex.., and will be delivered by subject faculty.

Course Outcomes:

CO1 Identify various power semiconductor devices and study their control characteristics.

CO2 Understand the operation of analog and digital triggering circuits

CO3 Analyze different converters for power conversion system and their applications.

CO4 Apply the knowledge of different power conversion system for the control of DC drives.

CO5. Apply the knowledge of different power conversion system for the control of AC drives

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10		3	1	2	1		2	2		2		3
2.	CO2	2	10	3	3	3	2	2	2	2	2		2		3
3.	CO3	3	12	3	3	2	2	2	2	2	2		2		3
4.	CO4	3,4	12	3	3	2	2	2	2	3	2		2		3
5.	CO5	3,4	8	3	3	2	2	3	2	3	2		2		3
Average CO				3	3	2	2	2	2	3	2		2		3

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcomes	PSO1	PSO2	PSO3
CO1	1	1	
CO2	2	3	
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

Average CO	3	2	3

Text Books.

1 M.H.Rashid "Power Electronics", First Edition, P.H.I. /Pearson, New Delhi, 2nd Edition, 2002

2 Ned Mohan, Tore M. Undeland, and William P. Robins, "Power Electronics - Converters, Applications and Design,", 3rd Edition, John Wiley and Sons, 2012

3 Gopal K.Dubey, "Fundamentals of Electrical Drives", 2nd edition, Tata.Mc.Hill, 2015

Reference Text Books.

1. G.K. Dubey, S.R. Doradla, A. Joshi and R.M.K. Sinha, "Thyristorised Power Controllers", 2nd edition,New Age International Publishers.,2001
2. M.D. Singh and Khanchandani K.B, "Power Electronics ",2nd edition,Narosa Publishing House, , Reprint 2015
3. J.M. Jacob Thomson, "Power Electronics, Principles and Applications",2nd edition, Vikas Publications, 2010

Web Links.

1. M B Patil,IITB,"Sequel Applications for Classroom Teaching", , https://www.ee.iitb.ac.in/ ~sequel/ sequel_app.html
2. L Umananda, "Ngspice- Power Conversion circuits," IISc, Bengaluru https://swayam.gov.in/ nd1_noc20_ee12
3. G.Bhuvaneswari,IIT Delhi. https://onlinecourses.nptel.ac.in /108/101/108101126/,
4. Prof. Vivek Agarwal, IIT, Bombay,Mumbai, "Fundamentals of Power Electronics" https://freevideolectures.com/ course/4266/ nptel-fundamental-power-electronics.

.

Subject Title : LINEAR ICS AND APPLICATIONS

Sub.Code: 18EE45 No. of Credits: 03=:2:2:0 (L - T – P) No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:52

Course Learning Objectives:

1. To understand the concepts of the basic characteristics and amp in AC amplifier circuits
2. To acquaint the students regarding frequency response and frequency compensating of op-amp..
3. To design & analyze different linear, non-linear & mathematical application circuits using op-amp
4. To understand the concepts of switched capacitor filters ,Voltage regulator and various amplifiers
5. To understand the basics of PLL and its practical applications.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**a) Introduction:** Operational amplifier description- Circuit symbol and terminals block diagram. Basic op-amp parameters - Input and output voltage range, offset voltage and current, offset nulling, CMRR, PSRR, input and output impedance**.** **b) OP-Amps as AC Amplifiers:** Capacitor-Coupled voltage follower, High Z_{in} Capacitor Coupled voltage follower, Capacitor-Coupled non-inverting amplifier, High Z_{in} Capacitor Coupled non-inverting amplifier, Capacitor-Coupled inverting amplifier, setting upper cut off frequency, use of single polarity supply. TEXT 1 and TEXT 2. Reference Book. 1 & 2	11	L1,L2,L3
2	**a) OP-Amp Frequency Response and Compensation:** Circuit stability, Frequency and phase response, Frequency compensating methods, Band width, slew rate effects, stray capacitance effects, load capacitance effects, Z_{in} mod compensation, and circuit stability precautions **b) Signal Processing Circuits:** Introduction, saturating precision half wave rectifier, non-saturating half wave precision rectifier, two output precision half wave rectifier, precision full wave rectifier using half wave rectifier and summing circuit, high input impedance full wave precision rectifier, peak clipper, dead zone circuit, precision clipper, precision clamping circuit, precision rectifier peak detector, voltage follower peak detector, sample and hold circuit. TEXT 1 and TEXT 2. Reference Book. 1 & 2	11	L2,L3
3	**a) OP-Amp Nonlinear Circuits:** Op-amps in switching circuits, zero crossing detectors, Inverting & Non inverting Schmitt trigger circuits, Astable multivibrator and monostable multivibrator.	10	L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	b) Signal Generators: Triangular wave generator, rectangular wave generator, phase shift oscillator, Wien bridge oscillator. TEXT 1 and TEXT 2. Reference Book. 1 & 2		
4	**Active Filters:** First order low pass active filter, second order low pass active filter, first order high pass active filter, second order high pass active filter, band pass filter, band stop filter. TEXT 1 and TEXT 2. Reference Book:2	10	L3,L4
5	**a) DC Voltage Regulators:** Basic linear voltage regulator, fixed output voltage regulators, adjustable output regulator(LM317/LM337), IC voltage regulators(IC723) **b) Specialized IC Applications:** Basics of universal active filter, basic phase lock loops, power amplifiers. TEXT 1 and TEXT 2. Reference Book 3	10	L2,L4,L5

Note 1: Unit 1 to 5 will have internal choice

Note2: a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5 .

c) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 5is a Webinar unit conducted through Google Classroom/ Zoom/Cisco-Webex and will be delivered by subject faculty.

Course Outcomes:

CO1 Describe the characteristics of ideal and practical operational amplifier.

CO2 Understand the behavior of op-amp linear and non- linear circuits.

CO3 Analyze the operation of op-amp in signal processing and oscillator circuits.

CO4 Analyze the operation of op-amp in filter circuits.

CO5 Design a circuit or system using integrated circuits (IC's).

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**1**	**11**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**2**	**-**	**1**
2.	CO2	**2**	**11**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**2**	**-**	**1**
3.	CO3	**3**	**10**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**2**	**-**	**1**
4.	CO4	**4**	**10**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**2**	**-**	**1**
5.	CO5	**5**	**10**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**2**	**-**	**1**
Average CO				**3**	**2**	**2**	**1**			**1**	**1**				**1**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	1	1
CO3	3	1	1
CO4	3	2	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 David A Bell, “Operational amplifiers and linear ICs”, Third Edition, Oxford University Press, 2010

2 B.Somanathan Nair,, “Linear Integrated Circuits - Analysis, Design and Applications”, First Edition, Wiley India,, 2009

Reference Text Books.

1 S. Salivahanan, V S KanchanaBhaaskaran, “Linear Integrated Circuits”, Second Edition , McGraw Hill, 2015

2 Stanley William D, “Operational amplifiers with Linear Integrated Circuits”, Fourth Edition Pearson Education, 2002

3 Ramakanth A Gayakwad, “Operational amplifiers and linear ICs”, Fourth edition, PHI, 2009

Web Links.

1. https://nptel.ac.in/courses/108/108/108108111/
2. https://www.yumpu.com/en/document/view/60502162/e-book-op-amps-and-linear-integrated-circuit-technology-by-ramakant-a-gayakwad

Subject Title : Transformers and Induction Machines Lab

Sub.Code:18EEL46 No. of Credits:1=0:0:1(L - T – P) No. of Lecture Hours/Week :02
Exam Duration:3 Hrs CIE +SEE=50+50=100 Total No.of Contact Hours:26

Course Learning Objectives:

1. To introduce various tests on Transformer, poly-phase Induction Machines and single-phase Induction Motor and evaluation of their performance.
2. To verify the parallel operation of two dissimilar transformers load sharing.
3. To learn various methods of speed control of Induction motor.
4. To study the connection of single phase transformers for three phase operation and phase conversion.
5. To study and calculation of equivalent circuit parameter of transformer and induction machine

Expt No	Experiment contents	No.of Hours	Blooms Taxnomy level.
1	(a) Predetermination of efficiency and regulation by Open Circuit and Short circuit tests on single - phase transformer. (b) Calculation of equivalent circuit parameters from the test data and determination of efficiency, Regulation from the equivalent circuit to correlate results obtained earlier.	2	L2,L3,L4
2	Sumpner’s test on similar transformers and determination of combined and individual transformer efficiency	2	L2,L3,L4
3	Parallel operation of two dissimilar (different kVA) single-phase transformers and determination of load sharing and analytical verification given the Open Circuit and Short circuit tests details.	2	L2, L3, L4
4	Connection of 3 single phase transformers star-detla, delta-star and determination of efficiency under balanced and Unbalanced resistive load	2	L2,L3, L4
5	Scott connection with balanced and unbalanced resistive loads.	2	L2,L3, L4

Expt No	Experiment contents	No.of Hours	Blooms Taxnomy level.
6	Load test on 3-phase Induction motor and determination of performance characteristics.	2	L2 L3,L4
7.	(a) NO load and Blocked rotor tests on 3-phase induction Motor Predetermination of performance from the Circle diagram. (b) Determination of parameters of the equivalent circuit of a 3-phase Induction Motor and correlate the results obtained from the circle diagram.	2	L2,L3,L4
8.	Speed control of 3-phase Induction motor by varying rotor resistance.	2	L2,L3,L4
9	Load test on- Induction generator.	2	L2,L3,L4
10	Load test on Single- Phase Induction motor.	2	L2,L3,L4
	Experiments beyond the Syllabus		
1	Polarity Test on Transformers	2	L2,L3
2	Determination of parameters of equivalent circuit of a 3-phase Induction Motor	2	L1,L2

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1	Conduct various tests on single-phase transformer, and evaluate their performance
CO2	Poly-phase induction machines and single-phase induction motor and evaluate their performance
CO3	Operate two dissimilar transformers in parallel for different load sharing.
CO4	Experiment the various methods of speed control of Induction motor.
CO5	Examine the connection of single phase transformers for three phase operation and phase conversion.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2,3,4**	**4**	3				2			2	1	1	2	
2.	CO2	**2,3,4**	**4**	3				3			1	2	1	1	
3.	CO3	**2,3,4**	**4**	3			2	2				1	1	1	
4.	CO4	**2,3,4**	**4**	3			3	2				1	1	1	
5.	CO5	**2,3,4**	**4**	3				2				1		1	
Average CO				3			3	2			2	1	1	1	

Course Outcomes Mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	3		1
CO2	3		1
CO3	3		1
CO4	3		1
CO5	3		1
Average CO	**3**		**1**

References Text Books.

1 I. J. Nagrath and D. P. Kothari,, "Electric Machines", 4th Edition, Tata Mc Graw Hill, 2010

2 B L Theraja, "Electrical technology-AC & DC Machines", S Chand Publishers

3 M.V Bhakshi, "Transformer and Induction Machine", Technical Publisher

Web Links.

1 https://www.svec.education/courses/eee-course-material-lab-manuals/

2 http://rmkcet.ac.in/eee-machines-lab.php/

3 https://www.slideshare.net/KamiWijaya/2-electrical-machines-lab

4 https://www.slideshare.net/sai55chaitanya/electrical-machines-2-lab-manual/

Subject Title : Power Electronics Lab

Sub.Code:18EEL47 No. of Credits:1=0:0:1(L-T-P) No. of Lecture Hours/Week :02

Exam Duration:3 Hrs CIE +SEE=50+50=100 Total No.of Contact Hours:26

Course Learning Objectives:

1 Study the characteristics of Power semiconductor devices practically.
2 Understand controllable switches in different power electronic circuit applications.
3 Understand to generate gating signals using analog and digital modules.
4 Learn to control the speed of electrical motors using power converters
5 Analyse to control power in converters circuits with different loads

Expt No	Experiment Contents	No.of Hours	Blooms Taxnomy level.
1	Static characteristics of SCR.	2	L1, L2
2	Static characteristics of MOSFET and IGBT.	2	L1, L2
3	SCR turn-on circuit using UJT relaxation oscillator.	2	L1, L2, L3,L4
4	SCR Digital triggering circuit for single phase controlled rectifier.	2	L2, L3, L4
5	Single-phase full-wave controlled rectifier connected to *R* and *R-L* loads- with and without freewheeling diode	2	L1, L2, L3
6	A.C. voltage controller using TRIAC – DIAC/UJT combination connected to *R* load.	2	L1, L2, L3
7.	To control the Speed of a stepper motor in half step, full step mode- both in forward and reverse direction.	2	L1, L2, L3
8.	To control the Speed of a universal motor using TRI AC	2	L2, L3
9	To control the Speed of a separately excited D.C. motor using an IGBT based chopper module.	2	L1, L2, L3, L4
10	To generate PWM signal using MOSFET based single-phase full-bridge inverter and study for variation in frequency and R load.	2	L1, L2, L3, L4
	Experiments beyond the Syllabus		
1	Study the performance of SCR forced commutating circuits. — (i) By reducing the forward current below the holding current (current commutation) (ii) By applying a large reverse voltage across conducting SCR (Voltage commutation)	3	L1, L2, L3, L4

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Understand the basic operation of various power semiconductor devices experimentally.

CO2 Illustrate the basic principles of triggering circuit.

CO3 Analyse the role of power electronics in utility-related applications

CO4 Understand the operation of different power converter circuits

CO5 Justify the use of Power Electronics converters for motor control applications.

Course outcomes Mapping with Programme Outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	6		3	1	2				2	2	2	2	2
2.	CO2	2	5	3	3	1	2				2	2	2	2	2
3.	CO3	3	5	3	3	1	2				2	2	2	2	2
4.	CO4	3	5	3	3	1	2				2	2	2	2	2
5.	CO5	4	5	3	3	1	2				2	2	2	2	2
Average CO				3	3	1	2				2	2	2	2	2

Course outcomes Mapping with Programme Specific Outcomes

Course Outcomes	PSO1	PSO2	PSO3
CO1	1	1	
CO2	2	3	
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3
Average CO	3	2	3

References Text Books.

1 M.H.Rashid "Power Electronics", First Edition, P.H.I. /Pearson, New Delhi, 2nd Edition, 2002

2 G.K. Dubey, S.R. Doradla, A. Joshi and R.M.K. Sinha, "Thyristorised Power Controllers", 2nd edition, New Age International Publishers., 2001

3 Dr Jyoti Koujalagi -Lab Manual

Web Links.

1 L Umananda,IISc, Bengaluru, Ngspice- Power Conversion circuits, https://swayam.gov.in/ nd1_noc20_ee12

2 M B Patil,IITB,"Sequel Applications for Classroom Teaching", , https://www.ee.iitb.ac.in/ ~sequel/ sequel_app.html

3 G.Bhuvaneswari,IIT Delhi, www.nptel.ac.in - https://nptel.ac.in/courses/108/101/108101126/

4. Prof. Vivek Agarwal, IISc , Bengaluru, "Fundamentals of Power Electronics ", https://freevideolectures.com/ course/4266/ nptel-fundamental-power-electronics.

Note: 20% program or experiments through virtual lab or any other online platform.

Subject Title : Signals and Systems

Sub.Code: 18EE51	No. of Credits:03=02:2:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1 To learn the different types of signals and properties of Signals & Systems, convolution for LTI systems.

2 To explain the use of convolution, differential in analysing the response of LTI systems in continuous and discrete time domains and to provide a block diagram representation to it.

3 To visualize the relationship between the continuous-time, discrete-time Fourier series and Fourier transform of a signal.

4 To learn the applications of Fourier transform.

5 To explain the use of Z-transform in the complex exponential representation of discrete time signals and the analysis of systems

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Introduction: Definition of A Signal and a System, Overview of Systems, Classifications of Signals, Basic Operation On Signals, Elementary Signals, And Systems Viewed as Interconnection of Operations, Properties of Systems. TEXT 1 and TEXT 2. Reference Book	10	L1,L2,L3.
2	Time Domain Representation for LTI Systems (Continuous & Discrete): Convolution, Impulse Response Representation, Properties of Impulse Response Representation, Solution of Differential & Difference Equations, Block Diagram Representation. TEXT 1 and TEXT 2. Reference Book	10	L1,L2,L3.
3	Frequency Domain Representation of Signals and Applications: Introduction, Fourier Representation of Continuous-Time Periodic Signals, Continuous Time Fourier Transform: Representation of Non Periodic Signals, Properties of Continuous Time Fourier Transforms. Application of Fourier Representation: Frequency Response of LTI Systems. Solutions of differential equation. TEXT 1 and TEXT 2. Reference Book	11	L1,L2,L3.
4	Discrete-Time Fourier Transform: Representation of non-periodic signals. The discrete time Fourier transforms (DTFT). Properties of Discrete Time Fourier Transform. Applications: Frequency Response of LTI Systems. Solution of Difference Equations Using System Function. Sampling of Continuous Time Signals & Signal Reconstruction. TEXT 1 and TEXT 2. Reference Book	10	L1,L2,L3.
5	Z- Transforms: Introduction, Z-transform, properties of ROC, properties of Z-transforms, inversion of Z-transform methods -	11	L1,L2,L3.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	power series and partial expansion, Transforms analysis of LTI systems, transfer function, stability and causality, unilateral Z-transform and its application to solve difference equations. TEXT 1 and TEXT 2. Reference Book		

Note 1: Unit 1 to 5 will have internal choice

Note2:
a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT presentation/subject quiz/project/seminar

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Characterize and analyse the properties of CT and DT signals and systems
CO2	Analyse LTI CT and DT systems in time domain using convolution & differential equation
CO3	Represent CT and DT signals in the Frequency domain using Fourier analysis tools.
CO4	Analyse Fourier transform for differential & difference equation applications.
CO5	Use Z-transform and properties of Z transform for the analysis of discrete time systems.

Course Outcomes Mapping with Programme Outcomes.

SI.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.	CO1:	1,2,3	09	3	2	1					1		1		1
2.	CO2.	1,2,3	12	3	3	1	2				2		2		2
3.	CO3:	1,2	09	3	3	1	2				2		2		2
4.	CO4:	3,4	13	3	3	1	2				2		2		2
5.	CO5:	1,2,3	09	3	3	1					2		2		2
Average CO				3	3	1	2				2		2		2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		1
CO2	3		1
CO3	3		1
CO4	3	2	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 Simon Haykin and Barry Vam Veen, "Signals & Systems", Reprint 2002 2nd edition , John Wiley & Sons, 2001

2 Alan V Oppenheim, Alan Willsky and S. Hamid Nawab , "Signals & Systems ", 2nd edition 1997, Pearson Education Asia , Indian Reprint 2002

3 Michael J Roberts, "Signals & Systems Analysis of signals through linear systems ", Tata McGraw Hill, 2003.

4 Nagoor Kani, "Signals and Systems ", 1st Edition 2010, Tata McGraw Hill.

Reference Text Books.

1 M J Roberts , "Signals & Systems ", Third edition , McGraw Hill, 2009

2 Dr D Ganesh Rao and Satish Tunga, "Signals & Systems ", Fourth edition , Sanguine, 2008

3 P Ramakrishna Rao and Shankar Prakriya , "Signal & Systems" Second edition Mcgraw Hill 2013

Web Links.

1 https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/lecture-notes/

2 https://www.sanfoundry.com/signals-systems-questions-answers-mcqs/

Subject Title : Field Theory

Sub.Code: 18EE52	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1. To understand the concept of Coulomb’s law, Gauss’ law and divergence and its applications
2. To understand the concept of energy, density, conductor and dielectrics and the boundary conditions for an electric field
3. To understand the concept of Poisson’s, Laplace law and magnetic field and its applications
4. To understand the concept of magnetic forces and magnetic materials
5. To understand the applications of Maxwell’s equations and time varying fields

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**a) Coulomb’s Law and electric field intensity:** Experimental law of Coulomb, Electric field intensity, Types of charge distributions. Field due to various charge distributions-Line charges, Surface charge, Volume charge. Fields due to infinite line charge, charged circular ring, infinite sheet charge. **b) Electric flux density, Gauss’ law and divergence:** Electric flux and flux density, Flux density for various charge distributions-Line charge, surface charge, volume charge. Gauss’ law, Divergence, Maxwell’s First equation (Electrostatics), vector operator and divergence theorem. TEXT 1 TEXT 2 and TEXT 3. Reference Books	12	L1,L2,L3,L4
2	**a) Energy and potential:** Energy expended in moving a point charge in an electric field, The line integral, Definition of potential difference and Potential, The potential field of a point charge and system of charges, Potential gradient, Energy density in an electrostatic field. **b) Conductors and dielectrics:** Current and current density, Continuity of current, metallic conductors, Conductor properties and boundary conditions, boundary conditions for perfect Dielectrics. TEXT 1 TEXT 2 and TEXT 3. Reference Books	10	L1,L2,L3,L4
3	**a) Poisson’s and Laplace’s equations:** Derivations of Poisson’s and Laplace’s Equations. Examples of the solutions of Laplace’s and Poisson’s equations. **b) The steady magnetic field:** Biot-Savart law, Ampere’s circuital law, Curl, Stokes’ theorem, magnetic flux and flux density, scalar and Vector magnetic potentials. TEXT 1 TEXT 2 and TEXT 3. Reference Books	10	L1,L2,L3,L4
4	**a) Magnetic forces and materials:** Force on a moving charge and differential current element, Force between differential current elements, Force and torque on a closed circuit.	10	L1,L2,L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	b) Magnetic materials: Magnetization and permeability, Magnetic boundary conditions, Magnetic circuit, Potential energy and forces on magnetic materials. TEXT 1 TEXT 2 and TEXT 3. Reference Books		
5	**Time varying fields and Maxwell's equations:** Faraday's law, displacement current, General field relations for time varying Electric and Magnetic fields. Maxwell's equation in point and Integral form. TEXT 1 TEXT 2 and TEXT 3. Reference Books	10	L1,L2,L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note2:
a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT presentation/subject quiz/project/seminar

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Able to define and state the behaviour of static electric fields in standard configurations.
CO2	Able to explain concepts of Energy and Potential to solve numerical problems.
CO3	Able to solve problems on Poisons and Laplace's equations, Biot-savarts law and Circuital laws.
CO4	Able to distinguish the behaviour of Electrostatic and electromagnetic fields between two dielectrics/conductor-dielectric boundaries
CO5	Able to apply Maxwell's equations for real time problems

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	**CO1**	**1,2**	**12**	3	3	2	1	1		1			1		2
2.	**CO2**	**1,2**	**10**	3	3	2				1			1		2
3.	**CO3**	**3**	**10**	3	3	2	1				1		1		1
4.	**CO4**	**4**	**10**	3	3	2	1			1			1		1
5.	**CO5**	**5**	**10**	3	3	2	1				1		1		2
Average CO				**3**	**3**	**2**	1	1		1	1		1		2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	2	2	2
CO2	2	2	2
CO3	2	2	2
CO4	2	2	2

CO5	2	2	2
Average CO	**2**	**2**	**2**

Text Books.

1 S. P. Basavaraju, “Field Theory”, First Edition, Sunstar Publisher, 2014

2 William H Hayt Jr. and John A Buck, “Engineering Electromagnetics”, 7th edition, Tata McGraw-Hill, 2006

3 J A Edminister, “Electromagnetics”, 2nd edition, Tata McGraw-Hill, 2006

Reference Text Books.

1 John Krauss and Daniel A Fleisch , “Electromagnetics with Applications”, 5th edition, Tata McGraw-Hill, 1999

2 Edward C. Jordan and Keith G Balmain, Prentice, “Electromagnetic Waves And Radiating Systems”, 2nd edition, Hall of India, 2008

Web Links.

1 Markus Zahn, “Electromagnetic Field Theory A Problem Solving Approach”, Massachusetts Institute of Technology

2 David H. Staelin, “Electromagnetics and Applications”, Massachusetts Institute of Technology

Subject Title : MICROCONTROLLER

Sub.Code:18EE53	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week :03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1. To understand the concept and Architecture of Microcontroller, logical Instruction & Assembly programming.
2. To learn branching Instructions & C- programming,
3. To learn timer operation, modes of operation, interrupts, serial programming,.
4. The learn programming languages instructions involved call and subroutine function
5. To make use of the Hardware Interfacing of ADC, DAC, Motor, LCD & Keyboard.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**The 8051 Architecture:** Introduction, 8051 microcontroller hardware, input/output pins, ports, circuits, external memory, counter and timers, serial data input/output, interrupts.	7	L2,L3,L4
2	**Addressing Modes and Operations**: Introduction, addressing modes, external data transfer, code memory, read only data moves/indexed addressing mode, push and pop. Data exchanges, example programs; byte level logical operations, bit level logical operations, rotate and swap operations, example programs. arithmetic operations: Flags, incrementing and decrementing, addition ,subtraction, multiplication and division, decimal arithmetic, program examples	8	L2,L3,L4
3	**Jump and Call Instructions:** The Jump and CALL program range, jumps, calls and subroutines, interrupts and returns, more details on interrupts, program example.8051 programming in c: data types and time delays in 8051 c, I/O programming, logic operations, data conversion programs, accessing code ROM space, data serialization.	7	L2,L3,L4
4	**Timer / Counter Programming in 8051**: Programming 8051 Timers, Counter programming, programming timers 0 and 1 using C/assembly language.	8	L2,L3,L4
5	**8051 Serial Communication**: Basics of serial communication, 8051 connections to RS-232, 8051 serial communication programming. **Interrupts Programming:** 8051 Interrupts, programming timer interrupts, programming external hardware interrupts, programming the serial communication interrupts, interrupt priority in the 8051/52. **8051 Interfacing Applications**: Interfacing 8051 to LCD, keyboard, parallel and serial ADC, DAC, stepper motor interfacing, DC motor interfacing and PWM.	9	L2,L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note2: a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

b) Group Activity for 5 Marks has to be evaluated through PPT presentation/subject quiz/project/seminar

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Explain the architecture & difference between Microprocessor & Microcontrollers.

CO2 Use the arithmetic and logical instructions.

CO3 Use the instructions for writing assembly language and C program.

CO4 Use timers in Assembly Language and C program.

CO5 Use interrupts for serial and external peripherals interface.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				a	b	c	d	e	f	g	h	i	j	k	l
1.	CO1	2,3,4	10	3	3	2	2		1						1
2.	CO2	2,3,4	11	3	3	2	2		1						1
3.	CO3	2,3,4	11	3	3	2	2		1						1
4.	CO4	2,3,4	10	3	2	2	2		1						1
5.	CO5	2,3,4	10	3	3	2	2		1						1
Average CO				3	3	2	2		1						1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	3	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 Kenneth J Ayla,, "The 8051 Microcontroller Architecture, Programming & Applications", 2nd Edition, Thomson Learning l, 2005

2 Muhammad Ali Mazidi, "The 8051 Microcontroller and Embedded Systems-Using Assembly and C", 2 Vol, PHI Pearson, 2010

3 Manish K Patel,"The 8051 Microcontroller Based Embedded Systems", 1st Edition, Tata Mcgraw Hill, 2014.

Reference Text Books.

1 K M Bhurchandi, A K Ray, "Advanced Microprocessors and Peripherals: With ARM and an Introduction to Microcontrollers and Interfacing",", 3rd Edition, Tata Mc GrawHill, 2012

2 S.K Mandal, "Microprocessors and Microcontrollers: Architecture, Programming & Interfacing using 8085, 8086, and 8051"", 2nd edition, Tata Mc GrawHill, 2011

3 Salvador PinillosGimenez,S.K Mandal, "8051 Microcontrollers: Fundamental Concepts, Hardware, Software and Applications in Electronics", 1st edition, Springer, 2019

4 S .Subrata Ghoshal.K Mandal, "8051 Microcontroller: Internals, Instructions, Programming and Interfacing", 2nd edition, Pearson, 2010

Web Links.

1 https://www.circuitstoday.com/4-books-to-learn-8051-microcontroller

2 http://web.mit.edu/6.115/www/document/8051.pdf

3 https://www.quora.com/What-are-the-best-books-for-8051-microcontroller

4 https://books.google.co.in/books/about/The_8051_Microcontroller.html?id=l6lveWkWqF

Subject Title : : Electrical Machine Design

Sub.Code: 18EE54	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Assmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1. To introduce the knowledge on basic principles of design, limitations and different materials used in electrical machines.
2. To understand the design concepts of Transformers.
3. To understand the problems on design of Transformers to satisfy the requirements
4. To understand the design concepts of AC and DC rotating electrical machines.
5. To understand the problems on design of AC and DC rotating electrical machines to satisfy the requirements.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Principles of Electrical Machine Design:** Introduction, considerations for the design of electrical machines, limitations. Different types of conducting, magnetic and insulating materials used in electrical machines. Design of Transformers (Single Phase and Three Phase): Output equation for single phase and three phase transformers, choice of specific loadings, expression for volts/turn, determination of main dimensions of the core, types of windings and estimation of number of turns and conductor cross sectional area of primary and secondary windings. TEXT 1 and TEXT 2. Reference Book1	12	L1-L5
2	**Estimation of Leakage Reactance and Tank Design of Transformer:** Estimation of no load current, expression for leakage reactance and voltage regulation. Design of tank and cooling tubes (round and rectangular). TEXT 1 and TEXT 2 Reference Book1	10	L1-L5
3	**Design of DC machines:** Output equation, choice of specific loadings and choice of number of poles, design of main dimensions of the dc machines, design of armature slot dimensions, Commutator and brushes, magnetic circuit - estimation of ampere turns, design of yoke and pole, field windings – shunt, series. TEXT 1 TEXT 2 Reference Book 1	10	L1-L5
4	**Design of induction Motors:** Output equation, choice of specific loadings, main dimensions of three phase induction motor, stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor, design of rotor bars and end ring, design of slip ring induction motor, estimation of no load current. TEXT 1 and TEXT 2. Reference Book1	10	L1-L5

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
5	**Design of Synchronous Machines:** Output equation, choice of specific loadings, short circuit ratio, design of main dimensions, design of the field winding, armature slots and windings, slot details for the stator of salient and non-salient pole synchronous machines. TEXT 1 and TEXT 2. Reference Book1	10	L1-L5

Note 1: Unit 1 to 5 will have internal choice

Note 2:
a) a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 2 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Apply the basic principles of design, and to select the best materials used in electrical machines
CO2	Explain design concepts of static electrical machines.
CO3	Analyse the design concepts of rotating electrical machines for the optimized performance.
CO4	To solve the design problems of static electrical machines.
CO5	To design the rotating electrical machines for the optimized performance.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.	CO1	**2**	**12**	2	3	3	1		1	1	1	1	1	1	1
1	CO2	**2**	**10**	2	3	2	1		1	1	1	1	1	1	1
3.	CO3	**4**	**10**	2	2	3	1		1	1	1	1	1	1	1
4.	CO4	**5**	**10**	2	3	2	1		1	1	1	1	1	1	1
5.	CO5	**5**	**10**	2	3	2	1		1	1	1		1		1
Average Co				2	3	2	1		1	1	1	1	1	1	1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	3	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 . A.K. Sawhney, "A Course In Electrical Machine Design", 4th edition, Dhanpatt Rai & Co, 2016

2 V. N. Mittle, " Performance And Design Of AC Machines ", 4th edition Standard Publishers Distributors

Reference Text Books.

1 M.G. Say, "Performance And Design Of AC Machines", edition, CBS Publishers and Distributors Pvt.Ltd.r, 2002

2 A. Shanmugasundarm, G. Gangadharan, R. Palani, "Design Data Handbook", edition,, year

Web Links.

1 https://www.quora.com/Where-can-I-get-a-A-K-Sawhney-PDF-of-a-course-in-electrical-machine-design

2 https://books.google.co.in/books/about/Design_Of_Electrical_Machines.html?id=7mTRGAAACAAJ

Subject Title : Control System Lab

Sub.Code: 18EEL56	No. of Credits:1=0:0:1 (L - T – P)	No. of Lecture Hours/Week : 02
Exam Duration:3 Hrs	CIE +SEE=50+50=100	Total No.of Contact Hours:26

Course Learning Objectives:

1. To study transient and steady state behaviour of linear control system.
2. To design compensating networks for improvement of stability.
3. To study frequency response of second order system.
4. To study time domain response characteristics of second order system.
5. To study AC/DC servomotor and P,I,D performance.

Expt No	Experiments	No.of Hours	Blooms Taxnomy level.
1.	Simulation of a typical second order system and determination of step response and evaluation of time- domain specifications using a software tool	2	L1-L4
2.	(a) Design of a passive RC lead compensating network for the given specifications, viz., the maximum phase lead and the frequency at which it occurs and to obtain its frequency response. (b) Experimental determination of transfer functions of a lead compensating network.	2	L1-L5
3	(a) Design of a RC lag compensating network for the given specifications. viz., the maximum phase lag and the frequency at which it occurs, and to obtain its frequency response. (b) Experimental determination of transfer functions of a lag compensating network.	2	L1-L5
4	Study of the effect of P, PI, PD and PID controller on the step response of a feedback control system (using control engineering trainer/process control simulator).	2	L1-L4
5	Speed – torque characteristic of a two - phase A.C. servomotor.	2	L1-L4
6	Speed torque characteristic of a D.C. servomotor.	2	L1-L4
7.	Experimental determination of frequency response of a second -order system and evaluation of frequency domain specifications	2	L1-L4
8.	Simulation of a D. C. position control system and its step response.	2	L1-L4
9	Determination of phase margin and gain margin of a transfer function by Bode Plots and verification by simulation.	2	L1-L4
10	Construction of root locus of transfer function and verification by simulation.	2	L1-L4
11	Synchro pair characteristics.	2	L1-L4
	Experiments beyond syllabus		
01	Determination of Observability and Controllability of a system in MATLAB.	2	L1- L4

Expt No	Experiments	No.of Hours	Blooms Taxnomy level.
02	Determination of phase margin and gain margin of a transfer function by Nyquist plot by MATLAB simulation.	2	L1-L4

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Understand and analyze the time and frequency domain specifications for a second order system.

CO2 Analyze the performance of servomotors.

CO3 Evaluating system performance using P,I,D controllers.

CO4 Design the control system with compensators.

CO5 Use MATLAB for simulation and validation of results obtained by analytical calculations.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	**2**	**4**	**3**	**3**		**3**	**3**			**1**		**1**	**1**	**1**
2.	CO2:	**3**	**4**	**3**	**3**		**3**	**3**			**1**		**1**	**1**	**1**
3.	CO3:	**5**	**2**	**3**	**3**		**3**	**3**			**1**		**1**	**1**	**1**
4.	CO4:	**6**	**4**	**3**	**3**	**3**	**3**	**3**			**1**		**1**	**1**	**1**
5.	CO5:	**2**	**8**	**3**	**3**		**3**	**3**			**1**		**1**	**1**	**1**
Average CO				**3**	**3**	**3**	**3**	**3**			**1**		**1**	**1**	**1**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	3	1
CO2	3	3	1
CO3	3	3	1
CO4	3	3	1
CO5	3	3	1
Average CO	**3**	**3**	**1**

Text Books.

1 Matlab user manual, Ogata.

References

1 Matlab by Rudrapratap.

Web Links.

1 http://vlabs.iitkgp.ernet.in/vlabs/vlab4/control/motorcontrol/closedloop/pidcontinuous/clpidc_aim.html

2 http://vlabs.iitkgp.ernet.in/vlabs/vlab4/control/motorcontrol/openloop/ol_aim.html

3 http://ialcoep.vlabs.ac.in/Expt6/Aim.html?domain=Electrical%20Engineering&lab=Industrial%20Automation%20Laboratory

4 http://209.211.220.205/vlabiitece/labs.php

Subject Title : DC MACHINES & SYNCHRONOUS MACHINES LAB

Sub.Code:18EEL57	No. of Credits:1=0:0:1(L - T – P)	No. of Lecture Hours/Week :02
Exam Duration:3 Hrs	CIE +SEE=50+50=100	Total No.of Contact Hours:26

Course Learning Objectives:

1 To introduce various testing methods for DC and synchronous machines.

2 To learn various losses occurring in DC machines and to find efficiency of a DC machines..

3 To learn the characteristics, performance and speed control of DC machines.

4 To determine voltage regulation of synchronous machines by various methods.

5 To study the behaviour of synchronous machine connected to infinite bus bars.

Expt No	Experiments Contents	No.of Hours	Blooms Taxnomy level.
1	Open circuit characteristics of DC machine.	2	L1, L2
2	Load characteristics of a D.C. shunt and compound generator - i) short shunt-cumulative and differential (ii) Long shunt-cumulative and differential.	2	L1,L2,L3.
3	Load test on a DC motor - determination of speed-torque and HP-efficiency characteristics.	2	L1, L2, L3,L4
4	Swinburne’s test.	2	L1, L2, L3,
5	Hopkinson’s test.	2	L1, L2, L3, L4
6	Speed control of DC motor by armature voltage control and flux control.	3	L1, L2, L3, L4
7.	Ward Leonard method of speed control of D.C. motor.	3	L1, L2, L3, L4
8.	Voltage regulation of an alternator by EMF and MMF method.	3	L1, L2, L3, L4
9	Voltage regulation of an alternator by ZPF method.	3	L1, L2, L3, L4
10	Slip test and determination of regulation.	3	L1, L2, L3, L4
11	Performance of synchronous generator connected to infinite bus under constant power and variable excitation.	3	L3.L4
12	V and Inverted V curves of a synchronous motor.		
	Experiments beyond syllabus		
01	Field’s test on series motors.	3	L1, L2, L3, L4
02	Load test on series generator.	3	L1, L2, L3, L4

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Choose proper testing method to determine losses and efficiency of a DC machine and to determine voltage regulation of synchronous generator.
CO2 Explain the characteristics of DC machines and synchronous machines by conducting suitable tests.
CO3 Apply the basic concept for experimental determination of voltage regulation of synchronous generator.
CO4 Analyze the performance of DC machines on load and synchronous machines on infinite bus bars.
CO5 Evaluate the losses and efficiency of DC machines and performance of synchronous machines connected to infinite bus bars.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	**1,2**	**4**	3	3			2				3			1
2.	CO2:	**1 - 3**	**5**	3	3			2				3			1
3.	CO3:	**1 - 3**	**5**	3	3			2				3			1
4.	CO4:	**1 - 4**	**5**	3	3			2				3			1
5.	CO5:	**1 - 4**	**5**	3	3	1		2				3			1
Average CO				3	3	1		2				3			1

Course outcomes mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	2
CO2	3	2	
CO3	3	2	2
CO4	3	2	
CO5	3	2	2
Average CO	**3**	**2**	

References Text Books.

1 Department manual.

Web Links.

1 http://vlab.amrita.edu/?sub=1&brch=75&sim=217&cnt=1

2 http://vlab.amrita.edu/?sub=1&brch=75&sim=322&cnt=1

Subject Title : PROGRAMMABLE LOGIC CONTROLLERS

Sub.Code: 18EE551	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 The need of automation in the industry with basic controller mechanisms involved.

2 The programming concepts to achieve the desired goal or to define the various steps involved in the automation.

3 The programming languages involved with basic subroutine functions.

4 To make use of the internal hardware circuits of automation circuit to control the devices during various states with monitoring the timers and counters

5 To handle the data of the I/O devices to interface the data with the controller and auxiliary devices.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Introduction:** programmable logic controller (PLC). Role in automation (SCADA). Advantages and Disadvantages, Hardware of PLC, Internal Architecture, Sourcing and Sinking, **Input and Output Devices:** Characteristics of I/O devices, List of input devices- mechanical switches, proximity switches, photoelectric sensor and switches, temperature sensor. Output devices- relay, directional control valve and motor. Examples of applications- conveyor belt, lift and Liquid level monitoring. TEXT 1 and TEXT 2.	8	L1,L2,L3
2	**I/O Processing:** Input unit / Output unit, Signal conditioning- changing voltage level, Remote connection- serial and parallel communication, serial standard. Networks and its types. **Programming**: Ladder Diagrams- PLC ladder programming, Logic Functions, Latching, Multiple Outputs, Function Blocks- Logic gates, Boolean Algebra, Program Examples- Signal lamp task, Valve operation program. TEXT 1 and TEXT 2.	8	L2,L3
3	**Programming Methods**: Instruction Lists- Ladder programs and Instruction lists, Branch codes, Programming Examples- Signal lamp task and Valve operation program. Sequential Function Charts- Branching and convergence. Structured Text- Conditional statement and iteration statements **Internal Relays**: internal relay, ladder programs- programs with multiple input conditions and Latching programs, Battery-Backed relays. TEXT 1 and TEXT 2.	8	L1,L2,L3
4	**ii) Internal relays**: One-Shot Operation, Set and Reset, Program Examples- Fire alarm system and Loading system, Master control relay. **Jump and Call**: jump- jumps within jumps, Subroutines call. **Timers**: Types of Timers, On-Delay Timers, Excluded- sequencing and cascaded timers. Off-Delay Timer, Pulse Timers, Programming Examples- Flashing light and Traffic light sequence. Counters: Forms of	8	L2,L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	Counter, Programming, Counter Application- Counting task. Up and Down counting. TEXT 1 and TEXT 2		
5	**Shift Registers**: Ladder Programs-4-bit shift register, Sequencing Application- sequencing cylinders and keeping track of faulty items. **Data Handling**: Registers and Bits, Data Handling- Data movement, Data comparison, Data Selection. Arithmetic Functions- Conversion BCD-to-binary and binary-to-BCD. TEXT 1	7	L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note 2:

a) a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 2 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Need of automation and its various control strategies with its auxiliary devices.

CO2 Programs for various functional block consisting of multiple inputs and outputs and to control

CO3 Programming issues with subroutines and debugged

CO4 The use of auxiliary units of a controller with hardware exposure.

CO5 The data handling with simple hardware.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	d	e	f	g	h	i	j	k	l
1.	CO1:	L1,L2,L3	8	3	1	1	2								
2.	CO2:	L2,L3,	8	3		2	1							1	
3.	CO3:	L1,L2,L3	8		3	2	1	2							
4.	CO4:.	L2,L3,L4	8	3	1							1		2	2
5.	CO5:	L3,L4	7				3	2		1				1	1
Average CO				3	2	2	2	2		1		1		1	2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1

CO4	3	3	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 W Bolton, “Programmable Logic Controllers”, 5th Edition, Elsevier- newness, 2009.

2 John W Webb, Ronald A Reis, “Programmable Logic Controllers - Principles and Applications”, 5th Edition, Pearson Education, 2007

Reference Text Books.

1 L.A.Bryan, E. A Bryan, “Programmable Controller Theory and Applications”, 2nd Edition, An Industrial Text Company Publication, 1997.

2 E. A Paar, “Programmable Logic Controllers”, 3rd Edition, An Engineers Guide. Newness, 2003.

3 Garry Dunning, “Introduction to Programmable Logic Controller”, 3rd Edition , Thomson Asia Pte Ltd. Publication , 2006

4 Rajesh Mehra, Vikrant Vij, “PLCs & SCADA - Theory and Practice”, 2nd Edition, laxmi publication, 2017

5 Kevin Collins, “PLC Programming for Industrial Automation”, 1st Edition, Kindle, 2016

Web Links.

1 news.mit.edu/topic

2 https://www.allaboutcircuits.com/textbook/digital/chpt-6/programmable-logic-controllers-

3 https://electrical-engineering-portal.com/download-center/books-and-guides/electrica

4 https://onlinecourses.nptel.ac.in

5 https://www.g-w.com/programmable-logic-controllers

Subject Title : VLSI Circuit Design

Sub.Code: 18EE552	No. of Credits:3=3:0:0(L-T-P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1. To introduce the present technology applied in the MOS Fabrication.
2. To design and analyze the basic electrical properties of various transistors and its electrical equivalent models.
3. To teach the students regarding the classical representations of the various transistors and to enable the electrical engineers to calculate the circuit parameters involved in the scaling process
4. Issues arising during the architectural and structural design of a basic sequential and clocked circuit is discussed
5. Be able to design models of moderately sized CMOS circuits that realize specified digital functions

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**A Review of Microelectronics and an Introduction to MOS Technology:** Introduction to Integrated Circuit Technology. Introduction, VLSI Technologies, MOS Transistors, Fabrication, Thermal Aspects, Production of E-Beam Masks. TEXT 1 and TEXT 2. Reference Book 1 & 2	08	L1,L2,L3.
2	**Basic Electrical Properties of MOS and BICMOS Circuit:** Drain to Source Current I_{ds} Versus V_{ds} Relationships- BICMOS Latch Up Susceptibility. MOS Transistor Characteristics, Figure Of Merit, Pass Transistor NMOS And CMOS Inverters, Circuit Model, Latch Up In CMOS Circuits TEXT 1 and TEXT 2. Reference Book 1 & 2	08	L1,L2,L3.
3	**MOS and BICMOS Circuit Design Processes:** MOS Layers, Stick Diagrams, Design, Symbolic Diagrams. **Basic Circuit Concepts and Scaling of MOS Circuits:** Sheet Resistance, Capacitance Layer Inverter Delays, Wiring Capacitance, Choice of Layers. Scaling Model and Scaling Factors- Limitations Due to Current Density. TEXT 1 and TEXT 2. Reference Book 1 & 2	08	L2,L3,L4
4	**Subsystem Design and Layout:** Architectural Issues, Systems Considerations. Examples of Structural Design, Clocked Sequential Circuits. TEXT 1 and TEXT 2. Reference Book 1 & 2	07	L2,L3,L4
5	**Subsystem Design Processes: G**eneral Considerations, Illustration of Design Process, Observations. **Illustration of The Design Process:** Observation On the Design Process, Regularity Design of an ALU Subsystem. Design of 4-	08	L2,L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	Bit Adder, Implementation of ALU Functions. TEXT 1 and TEXT 2. Reference Book 1 & 2		

Note 1: Unit 1 to 5 will have internal choice

Note 2:
c) a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
d) Group Activity for 5 Marks has to be evaluated through PPT Presentation/Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Impart knowledge of MOS transistor theory and CMOS technologies
CO2	Understand different properties of MOS and BICMOS circuits.
CO3	Analyze the design process of MOS and BICMOS circuits along with scaling of MOS circuits..
CO4	Understand and analyse subsystem design and layout.
CO5	To understand the process of subsystem design.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	**1**	**10**	**3**	**1**		**2**				**2**		**2**		**1**
2.	CO2	**2**	**11**	**3**	**1**		**2**				**2**		**2**		**1**
3.	CO3:	**3**	**11**	**3**	**1**		**2**				**2**		**2**		**1**
4.	CO4:	**4**	**10**	**3**	**1**		**2**				**2**		**2**		**1**
5.	CO5:	**5**	**10**	**3**	**1**		**2**				**2**		**2**		**1**
Average CO				**3**	**1**		**2**				**2**		**2**		**1**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	2		1
CO2	2		1
CO3	2	2	1
CO4	2	2	1
CO5	2	2	1
Average CO	2	2	1

Text Books.

1 Neil Weste, "Introduction to CMOS VLSI Design-A Circuits and Systems Perspective", Third Education, Pearson Publisher, 2006

2 Douglas Pucknell & Eshragian, "Basic VLSI Design", Third Education, PHI Publisher, 2009

Reference Text Books.

1. Yuan TaunTak H Ning Cambridge Press,"Fundamentals of Modern VLSI Devices", South Asia Edition, Cambridge Press Publisher, 2003
2. Wayne wolf,, "Modern VLSI Design", Third Edition, Pearson Education publisher, 2003

Web Links.

1. https://nptel.ac.in/courses/117/106/117106092/
2. https://www3.nd.edu/~kogge/courses/cse40462-VLSI-fa18/www/links.html
3. https://www.smartzworld.com/notes/vlsi-circuits-and-design-notes-vtu-vcd/

Subject Title : MODERN CONTROL THEORY

Sub.Code: 18EE553	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 To explain the concepts of basic and modern control system for the real time analysis and design of control systems.

2 To explain and apply concepts of state variables analysis.

3 To study and analyse nonlinear systems.

4 To analyse the concept of stability of nonlinear systems and categorization.

5 To apply the comprehensive knowledge of optimal theory for Control Systems.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**State Variable Analysis and Design**: Introduction, concept of state, state variables and state model, state modelling of linear systems, linearization of state equations. State space representation using physical variables, phase variables & canonical variables. TEXT 1 , TEXT 2 and TEXT 3. Reference Book 1 to 4	8	L1,L2,L3,L4
2	**Derivation of transfer function from state model**, Diagonalization, Eigen values, Eigen vectors, generalized Eigen vectors. Solution of state equation, state transition matrix and its properties, computation using Laplace transformation. TEXT 1, TEXT 2 and TEXT 3. Reference Book 1 to 4	8	L1,L2,L3,L4
3	**Concept of controllability & observability**, methods of determining the same, effect of pole zero cancellation, duality. TEXT 1, TEXT 2 and TEXT 3. Reference Book 1 to 4	7	L1,L2,L3,L4
4	**Pole Placement Techniques**: stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design. TEXT 1, TEXT 2 and TEXT 3. Reference Book 1 to 4	8	L1,L2,L3,L4
5	**Non-linear systems**: Introduction, behaviour of non-linear system, common physical non linearity-saturation, friction, backlash, dead zone, relay, multi variable non-linearity. Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories. TEXT 1, TEXT 2 and TEXT 3. Reference Book 1 to 4	8	L1,L2,L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note2:

a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes:

CO1	Understand the fundamentals of state variables, linear and nonlinear systems.
CO2	Analyze SISO and MIMO systems and obtain the state models.
CO3	Application of Eigen values for derivation of transfer functions.
CO4	Perform analysis on Controllability and Observability.
CO5	Improve stability of a given system by state feedback pole placement techniques.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2**	**8**	**3**	**3**	**1**	**2**	**1**			**2**		**2**		**1**
2.	CO2	**4**	**8**	**3**	**3**	**1**	**2**	**1**			**2**		**2**		**1**
3.	CO3	**3**	**8**	**3**	**3**	**1**	**2**	**1**			**2**		**2**		**1**
4.	CO4	**4**	**7**	**3**	**3**	**1**	**2**	**1**			**2**		**2**		**1**
5.	CO5	**4**	**8**	**3**	**3**	**1**	**2**	**1**			**2**		**2**		**1**
Average CO				**3**	**3**	**1**	**2**	**1**			**2**		**2**		**1**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	3	1
CO2	3	3	1
CO3	3	3	1
CO4	3	3	1
CO5	3	3	1
Average CO	**3**	**3**	**1**

Text Books.

1 M. Gopal, "Digital control & state variable methods.", 3rd Edition, TMH, 2008

2 I. J. Nagarath& M. Gopal, "Control system Engineering", 5th edition, New Age International (P) Ltd, 2007

3 Katsuhiko Ogata, "Modern Control Engineering", 5th Edition, Prentice Hall India, 1997

Reference Text Books.

1 Benjamin C. Kuo & Farid Golnaraghi, "Automatic Control Systems", 8th edition, John Wiley & Sons , 2009

2 D. Roy Choudary, "Modern Control Engineering", 4th reprint, PHI, 2009

3 Dorf & Bishop, "Modern control systems", 11th Edition, Pearson education, 2008

4 Katsuhiko Ogata, "State Space Analysis of Control Systems", 5th edition PHI, 1997

Web Links.

1 http://control.asu.edu/Classes/MMAE543/543Lecture01.pdf

2 http://eacademic.ju.edu.jo/alhusari/Material/ModernControlNotes.pdf

Subject Title : EMBEDDED SYSTEMS

Sub.Code:18EE554	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 Provide the knowledge about basic concepts of Embedded Systems.

2 Outline the concepts of typical embedded systems

3 Real-time systems: Identify the unique characteristic, explain general structure and define the unique design problems and challenges of real-time system

4 Understand basics, program, design, implement and test an embedded system and issues in designing.

5 Describe the concepts of real time operating system based embedded systems and Design and Development of Embedded Firmware.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Concept of Embedded System:** Introduction, Embedded System vs. General Computing Systems, History of Embedded Systems, Components, classification, skills required. Core of Embedded systems, Embedded Memories ROM variants and RAM. Major applications areas of embedded system, Purpose of Embedded Systems Examples of Embedded systems, 'Smart' Running Shoes from Adidas-The Innovative Bonding of Lifestyle with Embedded Technology. TEXT 1 and Reference Book	08	L1,L2
2	**Technological Aspects of Embedded System:** Interfacing between analog and digital blocks, Signal conditioning, digital signal processing, DAC & ADC interfacing, Signal conditioning using DSP. **Hardware Software Co-Design and Program Modeling:** Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modeling Language, Hardware Software Trade-offs. TEXT 1 and TEXT 2. Reference Book	08	L1,L2
3	**Design Trade Offs Due to Process Incompatibility, Thermal Considerations:** Issues in embedded system design. Design challenge, design technology, trade-offs. Thermal considerations, Embedded Firmware Design Approaches, Embedded Firmware Development Languages. TEXT 1 and TEXT 3. Reference Book	08	L1,L2,L3.
4	**Software aspects of Embedded Systems:** Real time programming Languages, operating systems. Programming concepts and embedded programming in C. Round Robin, Round	07	L1, L2, L3, L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	Robin with interrupts, Real time OS architecture, selecting architecture. Introduction to RTOS, Operating System Basics, Types of OS, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling. TEXT 1 and TEXT 2. Reference Book		
5	**Subsystem interfacing:** External system, user interfacing and Serial I/O devices, Parallel port interfaces: Input switches, Key boards and Memory interfacing. Trends in the Embedded Industry: Processor Trends in Embedded System, Embedded OS Trends, Development Language Trends, Open Standards, Frameworks and Alliances, Bottlenecks. TEXT 1 and TEXT 2. Reference Book	08	L1, L2, L3, L4

Note 1: Unit 1 to 5 will have internal choice

Note2:
a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 4 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Apply the knowledge of Microcontrollers to understand & explain the concepts of Embedded systems
CO2	Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems.
CO3	Design and Develop domain specific Embedded system applications.
CO4	Demonstrate understanding the facts of issues in embedded system design.
CO5	Design real time embedded systems using the concepts of RTOS and Analyze various examples of embedded systems by using the interfacing method.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2**	**08**	**2**	**1**	**1**	**2**				**2**	**1**	**2**		**2**
2.	CO2	**2**	**08**	**3**	**3**	**1**	**1**				**2**		**2**		**2**
3.	CO3	**5**	**08**	**2**	**3**	**3**	**2**	**2**			**2**	**2**	**2**	**3**	**3**
4.	CO4	**4**	**07**	**3**	**3**	**1**	**2**				**2**		**2**		**3**
5.	CO5.	**5**	**08**	**3**	**3**	**1**	**2**				**2**		**2**		**3**
Average CO				**3**	**3**	**1**	**2**	**2**			**2**	**1**	**1**	**1**	**3**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	1		
CO2	3	2	1

CO3	3	3	2
CO4	3	2	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 Raj Kamal, “4.Embedded System, Architecture, Programming and Design”, 2nd Edition, TMH, 2008

2 Valvano, J.W, “Embedded Microcomputer systems: Real time interfacing”, 2nd Edition 5th Indian reprint, 2009

3 Shibu K V “Introduction to Embedded Systems”, Tata McGraw Hill Education Private Limited, 2009

Reference Text Books.

1 Frank Vahid/Tony Givargis, “A Unified Hardware/Software Introduction”, Wiley student edition 2002. Choose an item., Choose an item.

2 Simon David, “Embedded Software Premier”, Addison Wessly 2000.

Web Links.

1 Motorola and Intel Manuals

2 www.nptel.com

Subject Title : Power Systems Analysis - I

Sub.Code: 18EE61	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Assignment +SEE=40+5+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1 Modelling of power system elements and representing the power system by single line diagrams.

2 Use symmetrical components in power system analysis.

3 Perform fault analysis on power system network.

4 Perform stability analysis on power system network

5 Evaluate the performance of induction machine under unbalanced supply conditions.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Representation of Power System Components:** Circuit models of transmission line, synchronous machines, transformers and load. Single line diagram, impedance and reactance diagrams. Per unit system, per unit impedance diagram of power system. **Symmetrical 3 - Phase Faults:** Transient, sub transient and steady state reactance's and currents of synchronous machines. Short-circuit currents of synchronous machines and power system, short circuit capacity of a bus. Selection of Circuit Breakers. TEXT 1,2 and Reference Book 1 & 4	12	L1-L4
2	**Symmetrical Components:** Introduction, three phase operator-a. Synthesis of unbalanced vector from its symmetrical components. Resolving the unbalanced phasors into their symmetrical components. Relation between symmetrical components of line & phase voltages in star connected system and line & phase currents in delta connected system. Phase shift of symmetrical components in transformer banks. Power in terms of symmetrical component. Analysis of unbalanced system using symmetrical components. Positive, negative and zero sequence networks of power system TEXT 1,2 and Reference Book 1	10	L1-L4
3	**Unsymmetrical Faults:** Introduction. Single line to ground fault (LGF), line to line fault (LLF) and double line to ground fault (LLGF): Determination of faults currents, terminal currents & voltages and connection of sequence networks. Fault with fault impedance. Fault on loaded synchronous generator. Unsymmetrical faults on power system. TEXT 1,2 and Reference Book 2 & 3	10	L1-L5
4	**Concept of System Stability:** Introduction, classification of stability, steady state and transient stability. Power angle equation of salient and non-salient pole machines. Power angle curves. Stability limits and methods to improving the stability. Rotor	10	L1-L5

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	dynamics and the swing equation. Equal area criterion and critical clearing angle & time. Apply equal area criterion for transient stability evaluation under different operating conditions of power system. TEXT 1,2 and Reference Book 3		
5	**Unbalanced Operation of Three Phase Induction Motors:** Open conductor faults in power system: sequence network connections. Analysis of three phase induction motor with one line open. Analysis of three phase induction motor with unbalanced supply. TEXT 2 Reference Book 3,4	08	L1-L5

Note 1: Unit 1 to 5 will have internal choice

Note 2:
a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group activity for 5 marks has to be evaluated through PPT presentation/ Subject Quiz/ Project/ Seminar

Note:3 Out of 5 Units, Unit 3 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Able to, recall the equivalent circuits of power system components and to draw the single line & impedance diagrams of power system network.

CO2 Apply concept of symmetrical components to power system network.

CO3 Analyze the behaviour of power system under different fault conditions.

CO4 Evaluate the steady state and transient stability of the Power Systems.

CO5 Investigate the effect of unbalanced operation and single phasing on the performance of three phase induction machines.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	2	08	3	2	2	3					1			2
2.	CO2:	3	08	3	2	2	2					1			2
3.	CO3:	4	08	3	2	3	2	1	1	2			1	2	2
4.	CO4:	5	08	3	3	3	3	1				1			2
5.	CO5:	5	07	3	3	3	1		1	1		1			1
Average CO				3	3	3	2		1	1		2	1	1	2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		1
CO2	3	2	1
CO3	3	2	1

CO4	3	2	1
CO5	3	2	
Average CO	**3**	**2**	**1**

Text Books.

1 W.D.Stevenson, “Elements of Power System Analysis”, Fourth Edition, TMH, 2013

2. I.J.Nagrath and D.P.Kothari, “Modern Power System Analysis”, 3rd Edition TMH, 2003

Reference

1 Hadi Sadat “Power System Analysis”, Second Edition, TMH, 2009

2 R.Bergen, and Vijay Vittal, “Power System Analysis”, 2nd edition, CRC Press, 2006.

3 G.L. Kusic. “Computer Aided Power system analysis”, PHI.Indian Edition, 2010

4 W.D. Stevenson & Grainger, “Power System Analysis”, Clarendon Press, Oxford, 1989.

5 Naser A and Boldea I, “Linear Electric Motors: Theory”, First Edition,Prentice, 2003

Web Links.

1 https://onlinecourses.nptel.ac.in/https://www.eeeguide.com/analysis-of-unsymmetrical-faultshttps://www.eeeguide.com/analysis-of-unsymmetrical-faults//

2 https://www.bvmengineering.ac.in/syllabi/UG1920/EE/3EE02.pdf

3 http://www.brainkart.com/subject/Special-Electrical-Machines_185/

Subject Title : High Voltage Engineering

Sub.Code: 18EE62	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Assignment +SEE=45+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 To introduce the need and basics and Applications of high voltage engineering.

2 Students will learn the break down mechanisms of insulating media.

3 Students will learn the concepts on generation of High AC. DC and impulse voltages and currents.

4 To learn techniques of measurement of High AC, DC and impulse voltages and currents.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Introduction:** Introduction to HV technology, role of insulation in electrical apparatus, types and applications of insulating materials used in transformers and Bushings and Rotating electrical machines. Need for generating high voltages in laboratory. Industrial applications of high voltages. **Conduction and breakdown in gaseous dielectrics:** Ionization: primary and secondary ionization processes. Criteria for gaseous insulation breakdown based on Townsend's theory. Limitations of Townsend's theory. Streamer's theory of breakdown in non-uniform fields. Corona discharges. Breakdown in electro negative gases. Paschen's law and its significance. Time lags of breakdown. **Solid dielectrics**: Breakdown in solid dielectrics: intrinsic breakdown, avalanche breakdown, thermal breakdown, and electro mechanical breakdown. **Liquid dielectrics**: Breakdown of liquid dielectrics: Suspended particle Theory, Cavity breakdown (Bubble's theory), and Stressed Oil Volume theory. Eco-friendly liquid dielectrics: introduction, Characteristic properties, advantages and disadvantages. TEXT 1 and TEXT 2. Reference 1	10	L1, L2, L3
2	**Generation of HVAC voltages:** HVAC-HV transformer; need for cascade connection and working of transformers units connected in cascade. Series resonant circuit- principle of operation and advantages. Tesla coil. **Generation of HVDC voltages:** Half and full wave rectifier circuits**,** voltage doubler circuit, Cockroft-Walton type high voltage generator set. Determination of voltage regulation, ripple and optimum number of stages for minimum voltage drop. Electrostatic generators - Van–de-Graff generator. TEXT 1 and TEXT 2 Reference 1	07	L1 -L4
3	**Generation of impulse voltage and current:** Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator-expression for output impulse voltage. Multistage impulse generator, working of modified Marx	8	L1-L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	multi stage impulse generator circuit. Rating of impulse generator. Components of multistage impulse generator. Triggering of impulse generator by three electrode gap arrangement. Trigatron gap and oscillograph time sweep circuits. Generation of switching impulse voltage generation of high impulse current. .TEXT 1 TEXT 2 Reference 1		
4	**Measurement of high voltages:** Electrostatic voltmeter-principle, construction and limitation. Chubb and Fortescue method for HVAC measurement. Generating voltmeter- principle, construction. Series resistance micro ammeter for HVDC measurements. Standard sphere gap- measurement of HVAC, HVDC, and impulse voltages; factors affecting the measurements. Potential Dividers-Resistance dividers, Capacitance dividers and mixed RC potential dividers. Measurement of high impulse currents- Magnetic links. TEXT 1 and TEXT 2. Reference Book 1	7	L1-L4
5	**High voltage tests on electrical apparatus**: Definitions of terminologies, tests on Insulators, Bushings and Transformers. Partial discharge measurements: Introduction, terminology used, methods of discharge detection- Straight discharge detection method and Balanced detection method. TEXT 1 and TEXT 2. Reference Book 1	7	L1-L5

Note 1: Unit 1 to 5 will have internal choice

Note 2:
a) a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 2 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Explain the need for high voltages and currents

CO2 Explain the physics of break down mechanisms of insulating media.

CO3 Compare the merits and demerits of generation of high voltage and currents.].

CO4 Select suitable method for measurement of high voltages and currents.

CO5 Explain the method of conducting the high voltage tests on different electrical equipment.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	1	10	3	2	1				1			1		1
2.	CO2	2	7	3	2	1				1			1		1
3.	CO3	4	8	2	3	1			1	1			1		1
4.	CO4	5	7	2	1	3			1	1			1		1

5.	CO5	5	7	3	2	1				1			1		1
Average CO				3	2	2			1	1			1		1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	2	2	1
CO3	3	1	1
CO4	2	1	1
CO5	3	1	1
Average CO	3	1	1

Text Books.

1. M.S.Naidu and Kamaraju, " High Voltage Engineering", 4th edition, TMH, , 2008
2. E.Kuffel and W.S. Zaengl, " High Voltage Engineering Fundamentals", 2nd Edition Elsevier Press, 2005.

Reference Text Books.

1. R.S. Jha, " High Voltage Engineering", edition, Dhanpat Rai & Sons, New Delhi , 1996
2. Mazen Abdel-Salam, Hussein Anis, Ahdab El- Morshedy, RoshdyRadwan, " High Voltage Engineering Theory and Practice", 2nd Edition,, 2003

Web Links.

1. https://www.academia.edu/12268238/High_Voltage_Engineering_CL_Wadhwa_PDF_BOok_Download
2. https://www.mv.helsinki.fi/home/tpaulin/Text/hveng.pdf

Subject Title : Digital Signal Processing

Sub.Code: 18EE63	No. of Credits:04=03:02:0 (L - T – P)	No. of Lecture Hours/Week : 05
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:65

Course Learning Objectives:

1. To understand DFT and its properties.
2. To learn FFT algorithm to find DFT.
3. To understand the structure of IIR & FIR system.
4. To learn Digital IIR filter design using analog filter transformation the applications of Fourier transform.
5. To learn Digital FIR filter design.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Discrete Fourier Transforms:** Definitions, properties-linearity, shift, symmetry etc., circular convolution – periodic convolution, use of tabular arrays, circular arrays, stock hams's method, linear convolution – two finite duration sequence, one finite & one infinite duration, overlap add and save methods. TEXT 1 and TEXT 2. Reference Book	13	L1,L2,L3.
2	**Fast Fourier Transforms Algorithms:** Introduction, decimation in time algorithm, number of computations, number of multiplications, computational efficiency, decimation in frequency algorithms, inverse decimation in time and inverse decimation in frequency algorithms, decomposition for a composite number N=9. TEXT 1 and TEXT 2. Reference Book	13	L1,L2,L3.
3	**Realization of Digital Systems:** Introduction, block diagrams and SFGs, realization of IIR systems- direct form, cascaded, parallel form, realization of FIR systems – direct form, cascade form, linear phase realization. TEXT 1 and TEXT 2. Reference Book	13	L1,L2,L3.
4	**Design of IIR Digital Filters:** Introduction, impulse invariant & bilinear transformations, all pole analog filters- Butterworth &chebyshev, design of digital Butterworth & chebyshev, frequency transformations. TEXT 1 and TEXT 2. Reference Book	13	L1,L2,L3.
5	**Design of FIR Digital Filters:** Introduction, windowing, rectangular, modified rectangular, Hamming, Hanning, blackman window(excluding Kaiser window), frequency sampling techniques.	13	L1,L2,L3.

Note 1: Unit 1 to 5 will have internal choice

Note2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5 and Group Activity for 5 Marks

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit and will be delivered by subject faculty.

Course Outcomes:

CO1 Analyse and find DFT of signals.

CO2 Analyse and find DFT using FFT algorithms.

CO3 Realize structures for FIR & IIR systems.

CO4 Design IIR filters for the given specifications.

CO5 Design FIR filters for the given specifications.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:.	1,2,3	13	3	3		2				1		1		1
2.	CO2.	1,2,3	13	3	3		2				1		1		1
3.	CO3:	1,2	12	3	3		2				1		1		1
4.	CO4:	3,4,5	13	3	3	2	2				1		1		1
5.	CO5:	3,4,5	14	3	3	2	2				1		1		1
Average CO's				3	3	2	2				1		1		1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	1	1
CO2	3	2	1
CO3	3	1	1
CO4	3	2	1
CO5	3	2	1
Average CO	3	2	1

Text Books.

1 Dimitris Manolakis and Johm G Proakis, "Digital Signal Processing Principle, Algorithm & application ", 4th education, Pearson, 2009

2 Sanjeet. K. Mitra , "Digital Signal Processing ", 3rd edition, TMH, 2009

Reference Text Books.

1 Johnny R. Johnson , "Introduction to Digital Signal Processing ", 4th edition , PHI, 2009

2 Alan V Oppenheim, Ronald W. Schafer and John R Buck, "Discrete Time Signal Processing ", 2nd edition , Pearson, 2009

3 S.Salivahanan, A.Vallaraj, C.Gnanapriya , "Digital Signal Processing" Second edition Tata McGraw Hill 2010

Web Links.

1. https://usermanual.wiki/Document/SOLUTIONMANUAL4thDigitalSignalProcessingProakisandManolakis.530579026/help
2. https://www.engineeringbookspdf.com/digital-signal-processing-ramesh-babu/

Subject Title : Digital Signal Processing Lab

Sub.Code: 18EEL65 | No. of Credits:1=0:0:1 (L - T – P) | No. of Lecture Hours/Week : 02
Exam Duration:3 Hrs | CIE +SEE=50+50=100 | Total No.of Contact Hours:26

Course Learning Objectives: Students will learn

1. To write program for computation of DFT, Circular Convolution & Linear convolution
2. To write program to find Impulse response of LTI system.
3. To write program for IIR filter design.
4. To write program for FIR filter design

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Direct Computation of N-point DFT.	2	L1, L2
2	IIR filter realization using cascade form, Parallel form	2	L1,L2,L3.
3	IIR Filter Design using Butterworth method.	2	L1, L2, L3,L4,L5
4	IIR Filter Design using Chebyshev type 1 prototype.	2	L1, L2, L3, L4,L5
5	FIR Filter Design using rectangular, hamming, window.	2	L1, L2, L3, L4,L5
6	FIR Filter Design using Hanning, Blackman window.	2	L1, L2, L3, L4,L5
7.	N-Point Circular Convolution and Proof in frequency domain.	2	L1, L2, L3
8.	Circular Convolution, Linear Convolution and Linear Convolution using Circular Convolution.	2	L1, L2, L3
9	Sampling Theorem.	2	L1, L2, L3
10	Impulse response from X[n] and y[n].	2	L1, L2, L3
11	Impulse response from difference equation and response to x[n].	2	L1, L2, L3
	Experiments beyond the Syllabus		
1	N-point DFT using decimation in Time and Frequency FFT.	2	L1, L2, L3
2	N-point IDFT using decimation in Time and Frequency FFT.	2	L1, L2, L3

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes: The Students will be able to

CO1 Write & execute the program to find DFT, Circular Convolution & Linear convolution
CO2 Write & execute program to find Impulse response of LTI system.
CO3 Differentiate & Write program for FIR & IIR Filter Structures

CO4 Design & Write program for IIR filters.
CO5 Design & Write program for FIR filters.

Course outcomes Mapping with Programme Outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	2	08	3	3		1	2			2	2	2	2	1
2.	CO2:	2	06	3	3		1	2			2	2	2	2	1
3.	CO3:	2,3	02	3	3		1	2			2	2	2	2	1
4.	CO4:	3,4,5	06	3	3	3	2	2			2	2	2	2	1
5.	CO5:	3,4,5	04	3	3	1	2	2			2	2	2	2	1
Average CO				3	3	2	1	2			2	2	2	2	1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	3	1
CO2	3	3	1
CO3	3	3	1
CO4	3	3	1
CO5	3	3	1
Average CO	**3**	**3**	**1**

Text Books.& References

1 S.Salivahanan, A.Vallaraj, C.Gnanapriya , “Digital Signal Processing ”, Second Edition, Newnes , 2010

2 Robert J Schilling and Sandra L Harris, “Fundamentals of Digital Signal Processing using MATLAB”, India Edition, Cengage Learning,2005.

3 Digital Signal Processing user Manual

Web Links.

1 http://www.geethanjaliinstitutions.com/engineering/labmanuals/downloads/ece/dsp%20lab.pdf

2 http://eceweb1.rutgers.edu/~orfanidi/ece348/labs-2011.pdf

Subject Title: MICROCONTROLLER LAB

Sub.Code:18EEL66	No. of Credits:1=0:0:1(L - T – P)	No. of Lecture Hours/Week :02
Exam Duration:3 Hrs	CIE +SEE=50+50=100	Total No.of Contact Hours:26

Course Learning Objectives:

1. To provide a practical introduction to microcontrollers assembly language & embedded C programming techniques, hardware interfacing circuit.
2. To explain writing ALP for data transfer, arithmetic, Boolean and logical instructions.
3. To explain writing assembly language programs for code conversions..
4. To perform interfacing of stepper motor and dc motor for controlling the speed.
5. To explain generation of different waveforms using DAC interface.

Expt No	Experiments Contents	No.of Hours	Blooms Taxnomy level.
I. PROGRAMMING:			
1	Data Transfer - Block move, Exchange, Sorting, Finding largest element in an array.	2	L2,L3,L4
2	Arithmetic Instructions - Addition/subtraction, multiplication and division, square, Cube – (16 bits Arithmetic operations – bit addressable).	2	L2,L3,L4
3	Counters.	2	L2,L3,L4
4	Boolean & Logical Instructions (Bit manipulations).	2	L2,L3,L4
5	Conditional CALL & RETURN.	2	L2 L3,L4
6	Code conversion: BCD – ASCII; ASCII – Decimal; Decimal - ASCII; HEX - Decimal and Decimal - HEX.	2	L2,L3,L4
7	Programs to generate delay, Programs using serial port and on-Chip timer / counter.	2	L2,L3,L4
II. INTERFACING 8051 CHIP USING C PROGRAMS			
8	Simple Calculator using 6 digit seven segment display and Hex Keyboard.	2	L2,L3,L4
9	Alphanumeric LCD panel and Hex keypad input.	2	L2,L3,L4
10	External ADC and Temperature control.	2	L2,L3,L4
	Experiments beyond the syllabus		

Expt No	Experiments Contents	No.of Hours	Blooms Taxnomy level.
1	Generation of different waveforms - Sine, Square, Triangular, Ramp etc. using DAC; changing the frequency and amplitude	2	L2,L3.L4
2	Stepper and DC motor control.	2	L2,L3.L4

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Understand different instruction set and architecture of 8051 Microcontroller.

CO2 Write &Analyze assembly language programming.

CO3 Understand usage of directives, Code Memory & external memory.

CO4 Write assembly language program using bit instructions.

CO5 Build Interfacing Circuit using embedded C programming.

Course outcomes Mapping with Programme Outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	2,3,4	2	3	1	1			2						2
2.	CO2:	2,3,4	2	3	1	1			2						2
3.	CO3:	2,3,4	2	3	1	1			2						2
4.	CO4:	2,3,4	2	3	1	1			2						2
5.	CO5:	2,3,4	2	3	1	1			2						2
Average CO				3	1	1			2						2

Course outcomes Mapping with Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4	3	3	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books & References:

1 Kenneth J Ayla, “Operate The 8051 Microcontroller Architecture, Programming & Applications System Principles”, 2nd Edition, Penram International, Thomson Learning, 2005

2 Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D McKinlay, “The 8051 Microcontroller and Embedded Systems-Using Assembly and C”, 2nd Edition, Pearson Publisher, 2006

Web Links.

1 https://www.svec.education/courses/eee-course-material-lab-manuals/

2. https://hsit.ac.in/dept-doc/EE/lab-manual/15EEL57-MC-LAB-MANUAL.pdf

Subject Title : Special Electrical Machines

Sub.Code: 18EE642	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Assignment +SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 To understand the constructional aspects of Special electrical machines

2 To understand the speed torque characteristics of Special electrical machines

3 To analyse the necessity of sensors used in Special electrical machines

4 To understand the concepts of converters and control schemes of Special electrical machines

5 To understand the merits, demerits and applications of Special electrical machines

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Stepper Motor:** Types of motors, construction, working principle. Term & definitions- Step angle, resolution, slewing, etc. Excitation modes, switching circuits, open and closed loop control, torque equation, speed torque characteristic, digital control of motor, comparison and applications of stepper motors. TEXT 1 and Reference Book 1 & 4	08	L1-L4
2	**Switched Reluctance Motor (SRM):** Construction, working principle, Inductance profile, pole arc and tooth arc constraints, torque equation, characteristics, power converter circuits, sensors-Hall and Optical, current regulators, sensor less and digital control, merits, demerits and applications. TEXT 1 and Reference Book 2	08	L1-L4
3	**Brushless Permanent Magnet DC (BLDC) Motor:** Introduction to PMDC motors. BLDC motors: Classification, construction, principle of operation, types of motor, electronic commutation, emf equation and waveforms, Torque equation, sensors, sensor less and digital control, comparison of brushed and brushless dc motors, merits, demerits and applications. TEXT 1 and Reference Book 2 & 3 Reference Book 2	08	L1-L5
4	**Permanent Magnet Synchronous Motor (PMSM):** Construction, principle of operation, emf equation, torque equation, sensor less and digital control, phasor and circle diagrams, comparison with conventional motors, applications. TEXT 1 and Reference Book 3	08	L1-L5
5	**Linear Induction Motor and Axial Flux Machines:** LIM: Construction, types, Principle of operation, thrust equation, and applications. **AFM:** Construction, types, Principle of operation, windings, torque and emf equations, applications. TEXT 1 and Reference Book 5	07	L1-L5

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.

Note 1: Unit 1 to 5 will have internal choice

Note 2:

c) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

d) Group activity for 5 marks has to be evaluated through PPT presentation/ Subject Quiz/ Project/ Seminar

Note:3 Out of 5 Units, Unit 3 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Able to describe the construction and operation of different special electrical machines

CO2 Compare merits, demerits of different special electrical machines and their applications.

CO3 Analyse different power converter topologies for operation of special electrical machines

CO4 Formulate the torque equation and analyze speed –torque characteristics of special electrical machines.

CO5 Develop digital control techniques for the operation and control of special electrical machines.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.	CO1:	**2**	08	**3**	**3**	**2**	**1**	**2**	**2**			**1**	**1**		**2**
2.	CO2:	**3**	08	**3**	**3**	**2**	**1**	**2**	**2**			**1**			**2**
3.	CO3:	**4**	08	**3**	**3**	**2**	**1**	**2**		**2**			**1**		**2**
4.	CO4:	**5**	08	**3**	**3**	**2**	**1**	**2**							**2**
5.	CO5:	**5**	07	**3**	**3**	**2**	**1**	**2**	**1**	**1**					**2**
Average CO				3	3	3	2		1	1		2	1	1	2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	
Average CO	3	2	1

Text Books.

1 E.G. Janardhanan, "Special Electrical Machines", First Edition, PHI, 2009

Reference Text Books.

1 K. Venkataratnam "Special Electrical Machines", First, University Press, 2009

2 R.Krishnan, "Switched Reluctance motor Drives Modeling, Simulation" Analysis, Design, and Applications, CRC Press, 2015.

3 Miller, T.J.E. "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989

4 Kenjo, T, "Stepping Motors and their Microprocessor control", Clarendon Press, Oxford, 1989.

5 Naser A and Boldea I, "Linear Electric Motors: Theory, Design and Practical Application", Prentice Hall Inc., New Jersey,1987

Web Links.

1 https://onlinecourses.nptel.ac.in/

2 https://www.academia.edu/9885014/SPECIAL_ELECTRICAL_MACHINES_NPTEL_NOTES

Subject Title : Artificial Intelligence Techniques for Electrical Engineering

Sub.Code: 18EE643 No. of Credits03=03:0:0 (L - T – P) No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs CIE+Assmt+GA +SEE=40+5+5+50=100 Total No.of Contact Hours:39

Course Learning Objectives:

1 To locate soft commanding methodologies, such as artificial neural networks, Fuzzy logic and genetic Algorithms.

2 To observe the concepts of feed forward neural networks and about feedback neural networks.

3 To practice the concept of fuzziness involved in various systems and comprehensive knowledge of fuzzy logic control and to design the fuzzy control.

4 To analyse genetic algorithm, genetic operations and genetic mutations.

5 To learn application of AI to power systems.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Artificial Neural Networks:** Introduction-Models of Neural Network – Architectures – Knowledge representation – Artificial Intelligence and Neural networks – Learning process – Error correction learning – Hebbian learning – Competitive learning – Boltzmann learning – Supervised learning – Unsupervised learning – Reinforcement learning – learning tasks. TEXT 1 and 2. Reference 1 - 4	07	L1 -L4
2	**ANN Paradigms:** Multi – layer perceptron using Back propagation Algorithm-Self – organizing Map – Radial Basis Function Network – Functional link, network – Hopfield Network. TEXT 1 and 2. Reference 1 - 4	08	L1 -L4
3	**Fuzzy Logic:** Introduction – Fuzzy versus crisp – Fuzzy sets – Membership function – Basic Fuzzy set operations – Properties of Fuzzy sets – Fuzzy Cartesian Product – Operations on Fuzzy relations – Fuzzy logic – Fuzzy Quantifiers – Fuzzy Inference – Fuzzy Rule based system – Defuzzification methods**.** TEXT 1 and 2. Reference 1 - 4	08	L1-L4
4	**Genetic Algorithms:** Introduction-Encoding – Fitness Function-Reproduction operators – Genetic Modeling – Genetic operators – Crossover – Single–site crossover – Two-point crossover – Multi point Crossover-Uniform crossover – Matrix crossover – Crossover Rate – Inversion & Deletion – Mutation operator – Mutation – Mutation Rate-Bit-wise operators – Generational cycle-convergence of Genetic Algorithm. TEXT 1 and 2. Reference 1 - 4	08	L1 -L4
5	**Applications of AI Techniques:** Load forecasting – Load flow studies – Economic load dispatch – Load frequency control – Single area system and two area system – Small Signal Stability	08	

	(Dynamic stability) Reactive power control – speed control of DC and AC Motors. TEXT 1 and 2. Reference 1 - 4		

Note 1: Unit 1 to 5 will have internal choice

Note 2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

CO1 Understand feed forward neural networks, feedback neural networks and learning techniques.

CO2 Analyze fuzziness involved in various systems and fuzzy set theory.

CO3 Develop fuzzy logic control for applications in electrical engineering

CO4 Develop genetic algorithm for applications in electrical engineering

CO5 Apply AI to study and analyse power system problems.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	1 - 4	07	3	3	3	2	3							1
2.	CO2	1 - 4	08	3	3	3	2	3							1
3	CO3	1 - 4	08	3	3	3	2	3							1
4.	CO4	1 - 4	08	3	3	3	2	3							1
5.	CO5	1 - 4	08	3	3	3	2	3							1
Average COs				3	3	3	2	3							1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	
Average CO	3	2	1

Text Books.

1 D.W.Patterson, "Introduction to Artificial Intelligence and Expert Systems", PHI, 2009

2 S. Rajasekaran and G. A. V. Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms", 13th Edition, PHI, New Delhi, 2003

Reference Text Books.

1 P. D. Wasserman, Van Nostrand Reinhold, "Neural Computing Theory & Practice", Newyork, 1989

2 Bart Kosko, "Neural Network & Fuzzy System", , PHI, Pvt.Ltd, 1992

3 G. J. Klir and T. A. Folger, “Fuzzy sets, Uncertainty and Information”, 2 nd edition, PHI Private Limilted, 1994

4 D. E. Goldberg, “Genetic Algorithms”, Addison Wesley 1999

Web Links.

1 https://nptel.ac.in/

Subject Title : Electric Vehicle Technology

Sub.Code: 18EE644	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1. Understand and acquire knowledge of battery driven electric vehicle, characteristics and their applications.
2. Acquire knowledge about vehicle dynamics, Motors, Power Electronics, Batteries, and Charging
3. Study the performance of different types of electric drives.
4. Learn vehicle dynamics with constant and variable parameters
5. Analyse through Mat lab/ Simulink tool in real time applications.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Introduction to Electric Vehicle:** History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Introduction to: Motor Drive Technologies; Energy Source Technologies; EV Battery Charging Technologies, Comparison of energy diversification of different types of vehicles. TEXT 1 and TEXT 2. Reference Book 1	07	L1,L2,L3.
2	**Intro EV Subsystems and Configurations:** Basics of vehicle performance; HEV Subsystems and Configurations; Modes of Operation: Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis. TEXT 1 and TEXT 2. Reference Book 1	08	L1,L2,L3.
3	**Vehicle Dynamics 1:**Mathematical models to describe vehicle performance; system level design & component level design, force-speed characteristics; tractive effort- gravitational force, air friction, the resistance offered by tire, rolling resistance etc.; different types of EV motors used for electric vehicle. TEXT 1 and TEXT 2. Reference Book 2	08	L2,L3.
4	**Vehicle Dynamics 2:**Dynamic equation with constant Fte- constant Tractive effort, terminal velocity, average power; Dynamic equation variable Fte- derivation of different dynamic equations with variable FTE- variable tractive effort and different regions of vehicle speeds. TEXT 1 and TEXT 2. Reference Book 2	08	L3,L4.
5	**Vehicle Dynamics Modelling and simulation:** Simulation of Vehicle dynamic equation constant Fte; Simulation of Vehicle dynamic equation variable Fte. Vehicle Dynamics Modelling and Simulation in Mat Lab/Simulink with real time application.	08	L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	TEXT 1 and TEXT 2. Reference Book 2		

Note 1: Unit 1 to 5will have internal choice

Note2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2.
a)Assignment -2 from Units 3, 4 and 5
b)Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 5is a Webinar unit conducted through Google Classroom/ Zoom/Cisco-Webex.., and will be delivered by subject faculty.

Course Outcomes:

CO1	Summarize the fundamental concepts of Electric Vehicles.
CO2	Understand principles of operation of hybrid and electric vehicles.
CO3	Analyze the Electric Vehicle dynamics with constant and variable parameters.
CO4	Apply Electric Vehicle dynamics for real time applications
CO5	Create dynamic model of Electrical vehicle using simulation tools

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	L1,L2,L3	09	3	2		1							1	
2.	CO2	L1,L2,L3	12	3		1	2	1							
3.	CO3	L2,L3	09				2						1	1	1
4.	CO4	L3,L4	9	3			1	1							1
5.	CO5	L3,L4	4	3		3				3					3
Average COs				3	2	2	2	1		3			1	1	2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcomes	PSO1	PSO2	PSO3
CO1	2	2	2
CO2	1	1	1
CO3	2	1	2
CO4	2	2	2
CO5	3	3	3
Average COs	2	2	2

Text Books.

1 Iqbal Husain,“ Electric and Hybrid Vehicles, Design Fundamentals”,CRC Press,2003

2 M. Ehsani, Y. Gao, S. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles" CRC Press,2005.

Reference Text Books.

1 Tom Denton. , "Electric And Hybrid Vehicles" Routledge / Taylor & Francis Group 2016.

2 Donald L Anglin & William H. Crouse, "Automotive Mechanics" ,McGraw-Hill,1985

3 Sira -Ramirez, R. Silva Ortigoza ,"Control Design Techniques in Power Electronics Devices",Springer

Web Links.

1 https://swayam.gov.in/nd1_noc20_ee18

2 https://youtu.be/Ay-4AZTnTEQ

3. Electric Vehicle Part -1,Dr Amit Jain,IIT Delhi. https://nptel.ac.in/courses/108/102/108102121/

Subject Title : SMART GRID TECHNOLOGY

Sub.Code: 18EE645	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 3
Exam Duration:03 Hrs	CIE+Asmt+GA+SEE=40+5+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives: After completion of the course, the student will be able to

1. Understand the features of smart grid
2. Study various smart transmission and distribution technologies
3. Appreciate distribution generation and smart consumption
4. Know the regulations and market models for smart grid..
5. Understand the distributed energy resources, home energy management systems

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Introduction to Smart Grids**: Definition, justification for smart grids, smart grid conceptual model, smart grid architectures, Interoperability, communication technologies, role of smart grids standards, intelligent grid initiative, national smart grid mission (NSGM) by Govt. of India .TEXT 1 and TEXT 2. Reference Book-1	07	L1,L2,L3.
2	**Smart Transmission Technologies**: Substation automation, Supervisory control and data acquisition (SCADA), energy management system (EMS), phasor measurement units (PMU), Wide area measurement systems (WAMS)TEXT 1 and TEXT 2. Reference Book-1	08	L1,L2,L3.
3	**Smart Distribution Technologies**: Distribution automation, outage management systems, automated meter reading (AMR), automated metering infrastructure (AMI), fault location isolation and service restoration (FLISR), Outage Management Systems (OMS), Energy Storage, Renewable Integration. TEXT 1 and TEXT 2. Reference Book-2	08	L1,L2,L3.
4	**Distributed Generation and Smart Consumption:** Distributed energy resources (DERs), smart appliances, low voltage DC (LVDC) distribution in homes / buildings, home energy management system (HEMS), Net Metering, building to Grid B2G, Vehicle to Grid V2G, Solar to Grid, Micro grid. TEXT 1 and TEXT 2. Reference Book-1	08	L1,L2,L3.
5	**Regulations and Market Models for Smart Grid:** Demand Response, Tariff Design, Time of the day pricing (TOD), Time of use pricing (TOU), Consumer privacy and data protection, consumer engagement etc. Cost benefit analysis of smart grid projects. TEXT 1 and TEXT 2. Reference Book-2	08	L1,L2,L3.

Note 1: Unit 1 to 5 will have internal choice

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.

Note2: c) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

d) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 1 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes: At the end of the course students will be able to

CO1	Understand technologies for smart grid
CO2	Understand technologies for smart grid.
CO3	Realize the distribution generation and smart consumption.
CO4	Know the regulations and market models for smart grid..

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10	3	3	1	2				2		2		2
2.	CO2	2	10	1	3	1	2				2		2		2
3.	CO3	2	12	2	3	1	2				2		2		2
4.	CO4	4	12	3	3	1	2				2		2		2
5.	CO5	5	8	3	3	1	2				2		2		2
Average Course Outcomes				3	3	1	2				2		2		2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		
CO2		2	
CO3			
CO4			1
CO5	3	2	
Average CO	**3**	**2**	**1**

Text Books.

1 Clark W Gellings, "The Smart Grid, Enabling Energy Efficiency and Demand Side Response", First Edition, CRC Press, 2009

2 Jean Claude Sabonnadière, NouredineHadjsaïd, "The Smart Grid, ", First Edition, Wiely ISTE IEEE Press, 2012

Reference Text Books.

1 JanakaEkanayake, KithsiriLiyanage, Jianzhong. Wu, Akihiko Yokoyama, Nick Jenkins, “. Smart Grid Technology and Applications”, 4th edition, Wiely Publication, 2012

Web Links.

1 https://www.smartgrid.gov/the_smart_grid/smart_grid.html

Subject Title : OOPS using C++

Sub.Code:18EE646 No. of Credits:03=03:0:0 (L - T – P) No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs CIE+Asmt+GA+SEE=40+5+5+50=100 Total No.of Contact Hours:39

Course Learning Objectives:

1 To understand Object Oriented Programming concepts using the C++ language
2 Introduces the principles of function, classes and objects.
3 Introduces to Constructors, Destructors and Operator overloading.
4 Introduces the principles of inheritance, pointers, virtual functions and polymorphism.
5 Introduces the concept of streams and handling files.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Beginning with C++ and its features:** What is C++? Applications and structure of C++ program, Different Data types, Variables, Different Operators, expressions, operator overloading and control structures in C++ . Topics from Chap-2,3 of Text 1 and Reference Book	07	L1,l2
2	**Functions, classes and Objects:** Functions, Inline function, function overloading, friend and virtual functions, specifying a class, C++ program with a class, arrays within a class, memory allocation to objects, array of objects, members, pointers to members and member functions. Selected Topics from Chap-4,5 of Text1 and Reference Book	08	L1,L2,L3.
3	**Constructors, Destructors and Operator overloading:** Constructors, Multiple constructors in a class, Copy constructor, Dynamic constructor, Destructors, Defining operator overloading, Overloading Unary and binary operators, Manipulation of strings using operators. Selected topics from Chap-6, 7 of Text 1 and Reference Book	08	L1,L2,L3.
4	**Inheritance, Pointers, Virtual Functions, Polymorphism:** Derived Classes, Single, multilevel, multiple inheritance, Pointers to objects and derived classes, this pointer, Virtual and pure virtual functions. Selected topics from Chap-8,9 of Text 1 and Reference Book	08	L1,L2,L3.
5	**Streams and Working with files:** C++ streams and stream classes, formatted and unformatted I/O operations, Output with manipulators, Classes for file stream operations, opening and closing a file, EOF. Selected topics from Chap-10, 11 of Text 1 and Reference Book	08	L1,L2,L3.

Note 1: Unit 1 to 5 will have internal choice

Note2:

a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit and will be delivered by subject faculty.

Course Outcomes:

CO1 Explain the basics of Object Oriented Programming concepts.

CO2 Apply the object initialization and destroy concept using constructors and destructors.

CO3 Apply the concept of run time polymorphism by using virtual functions, overriding functions and abstract class in programs and to implement compile time polymorphism in programs by using overloading methods and operators..

CO4 Use the concept of inheritance to reduce the length of code and evaluate the usefulness..

CO5 Use I/O operations and file streams in programs.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	**2**	**07**	**3**	**3**	**2**		**2**	**1**		**2**		**2**		**2**
2.	CO2	**3**	**08**	**3**	**3**	**2**		**3**	**1**	**2**	**2**		**2**		**2**
3.	CO3	**2**	**08**	**3**	**3**	**2**		**3**	**1**		**2**		**2**		**2**
4.	CO4	**4**	**08**	**3**	**3**	**2**		**3**	**1**	**2**	**2**		**2**		**2**
5.	CO5	**5**	**08**	**3**	**3**	**2**		**2**	**1**	**2**	**2**		**2**		**2**
Average CO				**3**	**3**	**3**		**3**	**1**	**2**	**2**		**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	3		
CO2		2	
CO3	3		
CO4		2	1
CO5	3	2	
Average CO	3	2	1

Text Books.

1 E. Balaguruswamy, "Object Oriented Programming with C++", 6th Edition, TMH,, 2013

Reference Text Books.

1 Robert Lafore, "Object Oriented Programming using C++", 2nd edition, Galgotia publication, 2010

Web Links.

1 www.nptel.com

Subject Title : COMPUTER TECHNIQUES IN POWER SYSTEMS ANALYSIS

Sub.Code:**EE 71** No. of Credits:04=03:1:0 (L - T – P) No. of Lecture Hours/Week : 05
Exam Duration:03 Hrs CIE+Assignment +SEE=45+5+50=100 Total No.of Contact Hours:65

Course Learning Objectives:

1 Understand network topology, form network incident matrices
2 Able to formulate Ybus and Zbus for the power system network
3 Perform Load flow analysis using different numerical techniques
4 Perform economic operation on power system.
5 Evaluate transient stability analysis of power system.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Network Matrices:** Introduction, elementary graph theory – oriented graph, tree, co-tree, cut set, loop. Incidence matrices: element-node, bus, basic cut set, basic loop. Primitive network – impedance form and admittance form. Formation of YBUS by method of inspection (including transformer off-nominal tap setting) and by method of singular transformation (YBUS = ATyA). Formation of bus impedance matrix by step by step building algorithm (without mutual coupling elements. TEXT 1, TEXT 2 and Reference Book 1 & 4	15	L1-L4
2	**Load Flow Studies 1**: Introduction, power flow equations, classification of buses, operating constraints, data for load flow, Gauss-Seidal method – formulation of voltage equation. Algorithm and flow chart for PQ and PV buses (numerical problems for one iteration only). TEXT 1, TEXT 2 and Reference Book 1 & 5	13	L1-L4
3	**Load Flow Studies 2:** Newton-Raphson's method – formulation of power residue equations, evaluation of Jacobian elements. Algorithm and flow chart in polar coordinates (numerical problems for one iteration only). Fast decoupled load flow. Comparison of load flow methods. TEXT 1, TEXT 2 and Reference Book 2 & 3	13	L2-L4
4	Economic Operation of Power System: Introduction, performance curves, economic generation scheduling neglecting losses and generator limits. Economic generation scheduling including generator limits and neglecting losses, iterative techniques. Economic dispatch including transmission losses – approximate penalty factor, iterative technique for solution of economic dispatch with losses. Derivation of transmission loss formula. TEXT 1, TEXT 3 and Reference Book 3 & 5	15	L2-L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
5	**Transient Stability Studies:** Introduction to transient stability. Numerical solution of swing equation – point-by-point method, modified Euler's method, Milne's Method, Runge-Kutta method. TEXT 1, TEXT 3 and Reference Book 4 & 5	09	L2-L4

Note 1: Unit 1 to 5 will have internal choice

Note 2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

Note:3 Out of 5 Units, Unit 3 is a Webinar unit and is conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Recall and relate the graph theory to Power System, define fundamental matrices and form Ybus and Zbus matrices

CO2 Classify the buses and formulate the power flow problems of power system network.

CO3 Solve the power flow problems through different iterative techniques..

CO4 Analyse the economic operation of power system under various operating conditions.

CO5 Evaluate the transient stability of the power system through different numerical methods.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.	CO1	2	08	3	2	2	3					1			2
2.	CO2	3	08	3	2	2	2					1			2
3.	CO3	4	08	3	2	3	2	1	1	2	1	1		2	2
4.	CO4	5	08	3	2	3	3	1			1	1			2
5.	CO5	5	07	3	2	3	1		1	1		1			1
Average CO				3	2	3	2	1	1	1	1	1		1	2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1
CO2	3	2	1
CO3	3	2	1
CO4	3	2	1
CO5	3	2	1
Average CO	**3**	**2**	**1**

Text Books.

1 D.P.Kothari, "Modern Power System Analysis", 4th Edition, McGrawHill, 2011

2 Stag G.W and EI-Abiad A.H., "Computer Methods in Power System Analysis", Student edition, McGraw Hill International, 1968

3 Haadi Sadat, "Power system Analysis", 2nd Edition, TMH, 2002

Reference Text Books.

1 R.N..Dhar "Computer Aided Power System Operations and Analysis", 2nd Edition, TMH, 1984

2 W.D. Stevenson, , "Elements of Power System Analysis", 4nd edition, TMH,2010

3 G.L. Kusic. "Computer Aided Power system analysis", PHI.Indian Edition, 2010

4 M.A.Pai, "Computer Techniques in Power Systems2nd Edition TMH, 2006

5 K. Uma Rao, "Computer Techniques and Models in Power System" Second Edition , IK International Publishing House Pvt. Ltd, 2008

Web Links.

1 https://onlinecourses.nptel.ac.in/

2 https://www.youtube.com/watch?v=_uoy5YV8C_8

Subject Title : High Voltage Engineering

Sub.Code: EE72	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Assignment +SEE=45+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1. To introduce the need and basics of high voltage engineering and to learn break down mechanisms of insulating media.
2. The concepts on generation of High AC. DC and impulse voltages and currents.
3. To learn techniques of measurement of High AC, DC and impulse voltages and currents
4. To identify the different techniques of testing high voltage equipments..

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**INTRODUCTION:** Introduction to HV technology, role of insulation in electrical apparatus, need for generating high voltages in laboratory. Industrial applications of high voltage, **Breakdown phenomena:** Classification of HV insulating media. Properties of important HV insulating media under each category. **Gaseous dielectrics**:Ionization: primary and secondary ionization processes. Criteria for gaseous insulation breakdown based on Townsend's theory. Limitations of Townsend's theory. Streamer's theory breakdown in non uniform fields. Corona discharges. Breakdown in electro negative gases. Paschen's law and its significance. Time lags of breakdown. **Solid dielectrics**: Breakdown in solid dielectrics: intrinsic breakdown, avalanche breakdown, thermal breakdown, and electro mechanical breakdown. **Liquid dielectrics**: Breakdown Of Liquid Dielectrics: Suspended Particle Theory, Cavity Breakdown (Bubble's Theory), Stressed Oil Volume Theory. TEXT 1 and TEXT 2. Reference 1	12	L1, L2, L3
2	**Generation of HVAC voltages:** HVAC-HV transformer; need for cascade connection and working of transformers units connected in cascade. Series resonant circuit- principle of operation and advantages. Tesla coil. **Generation of HVDC voltages:** Half and full wave rectifier circuits**,** voltage doubler circuit, Cockroft-walton type high voltage dc set. Calculation of voltage regulation, ripple and optimum number of stages for minimum voltage drop.Electrostatic generators - van–de-graffgenerator.TEXT 1 and TEXT 2 Reference 1	10	L1 -L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
3	**Generation of impulse voltage and current: I**ntroduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator-expression for output impulse voltage. Multistage impulse generator, working of modified Marx multi stage impulse generator circuit. Rating of impulse generator. Components of multistage impulse generator. Triggering of impulse generator by three electrode gap arrangement. Trigatron gap and oscillograph time sweep circuits. Generation of switching impulse voltage. Generation of high impulse current..TEXT 1 TEXT 2 Reference 1	10	L1-L4
4	**Measurement of high voltages:** Electrostatic voltmeter-principle, construction and limitation. Chubb and Fortescue method for HVAC measurement. Generating voltmeter- principle, construction. Series resistance micro ammeter for HVDC measurements. Standard sphere gap measurements of HVAC, HVDC, and impulse voltages; factors affecting the measurements. Potential dividers-resistance dividers capacitance dividers mixed rc potential dividers. Measurement of high impulse currents- magnetic links. TEXT 1 and TEXT 2. Reference Book 1	10	L1-L5
5	**Non-destructive insulation testing techniques:** Dielectric loss and loss angle measurements using Schering bridge, transformer ratio arms bridge. Need for discharge detection and pd measurements aspects. Factor affecting the discharge detection. Discharge detection methods-straight and balanced methods. **High voltage tests on electrical apparatus**: Definitions of terminologies, tests on Isolators, Circuit Breakers, Cables Insulators, Bushings and Transformers.TEXT 1 and TEXT 2. Reference Book 1	10	L1-L5

Note 1: Unit 1 to 5 will have internal choice

Note 2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

Note:3 Out of 5 Units, Unit 2 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Explain the need for high voltages and currents
CO2	Explain the physics of break down mechanisms of insulating media.
CO3	Compare the merits and demerits of generation of high voltage and currents.
CO4	Select suitable method for measurement of high voltages and currents.

CO5 To design the rotating electrical machines for the optimized performance [L4, PO3, PO9 and PO12].

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				a	b	c	d	e	f	g	h	i	j	k	l
1.	CO1	**1**	**10**	3	2	1				1			1		1
2.	CO2	**2**	**7**	3	2	1				1	1	1	1	1	1
3.	CO3	**4**	**8**	2	3	1			1	1	1	1	1	1	1
4.	CO4	**5**	**7**	2	1	3			1	1	1	1	1	1	1
5.	CO5	**5**	**7**	2	3	1			1	1	1	1	1	1	1
Avearge CO				3	2	1			1	1	1	1	1	1	1

Course Outcomes Mapping with Programme Specific outcomes with Course outcomes

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1
CO2	2	2	1
CO3	3	1	1
CO4	2	3	1
CO5	3	2	1
Average CO	**3**	**1**	**1**

Text Books.

1 M.S.Naidu and Kamaraju, “High Voltage Engineering”, 4th edition, TMH, , 2008

2 E.Kuffel and W.S. Zaengl, “ High Voltage Engineering Fundamentals”,2nd EditionElsevier Press,2005.

Reference Text Books.

1 R.S. Jha, “High Voltage Engineering”, edition, Dhanpat Rai & Sons, New Delhi , 1996

2 Mazen Abdel-Salam, Hussein Anis, Ahdab El- Morshedy, RoshdyRadwan, “High Voltage Engineering Theory and Practice”, 2nd Edition,,2003

Web Links.

1 https://www.academia.edu/12268238/High_Voltage_Engineering_CL_Wadhwa_PDF_Book_Download

2 https://www.mv.helsinki.fi/home/tpaulin/Text/hveng.pdf

Subject Title : : RELAY AND HIGH VOLTAGE LABORATORY

Sub.Code:18EEL74 No. of Credits:1.5=0:0:1.5(L - T – P) No. of Lecture Hours/Week :03

Exam Duration:3 Hrs CIE +SEE=50+50=100 Total No.of Contact Hours:39

Course Learning Objectives:

1 To study the characteristics of various protection devices.

2 To study the flashover characteristics of air insulation subjected to HVAC and HVDC under uniform and non-uniform field configuration.

3 To study the field distribution in the conductor dielectric medium.

4 To study the generation of standard lightning impulse voltage wave and to evaluate the front and tail times.

5 To measure the high AC and DC voltages using standard sphere gap model

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Operating characteristics of non-directional over-current (electro-mechanical) relay.	3	L1, L2
2	IDMT characteristics of over voltage or under voltage relay.(solid state or electromechanical type	3	L1,L2,L3.
3	a) To determine 50% probability flashover voltage for air insulation subjected to impulse voltage. (b) Generation of standard lightning impulse voltage and to determine efficiency and energy of impulse generator.	3	L1, L2, L3,L4
4	Operating characteristics of over voltage or under voltage relay. (Solid state or electromechanical type)..	3	L1, L2, L3
5	Current-time characteristics of fuse	3	L1, L2, L3, L4
6	Operating characteristics of microprocessor based (numeric) over – current relay.	3	L1, L2, L3, L4
7.	Operating characteristics of microprocessor based (numeric) over/under voltage relay.	3	L1, L2, L3, L4
8.	Motor protection scheme-fault studies	3	L1, L2, L3, L4
9	Spark over characteristics of air insulation subjected to high voltage AC, with spark over voltage corrected to STP for uniform and non-uniform field configuration.	3	L1, L2, L3, L4
10	Spark over characteristics of air insulation subjected to high voltage DC for uniform & non-uniform field configurations with spark-over voltage corrected to STP	3	L1, L2, L3, L4
11	Measurement of HVAC and HVDC using standard spheres.	3	L1, L2, L3, L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
12	Breakdown strength of transformer oil using oil-testing unit.	3	L1, L2, L3, L4
13	*Demonstration of: (i) Cascade connection of transformers. (ii) Measurement of partial discharges in underground cables.	3	L1, L2, L3, L4

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1 Identify the characteristics of protection devices for applications in power system protection.

CO2 Distinguish between the flashover characteristics of air insulation subjected to HVAC and HVDC under uniform and non- uniform field configuration.

CO3 Illustrate the generation of standard lightning impulse voltage wave and to evaluate front and tail times.

CO4 Asses the field strength in liquid insulation and field distribution in the dielectric medium through field plotting.

CO5	To measure the high AC and DC voltages using standard sphere gap model

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1:	**2**	**10**	3	2	2		1		1	1	1	1	1	1
2.	CO2:	**3**	**6**	3	3	1		1		1	1	1	1	1	1
3.	CO3:	**2**	**3**	2	3	1		1		1	1	1	1	1	1
4.	CO4:	**3**	**3**	2	3	1		1		1	1	1	1	1	1
5.	CO5:	**4**	**4**	3	2	1		1		1	1	1	1	1	1
Average CO				3	3	1		1		1	1		1	1	1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	**PSO1**	**PSO2**	**PSO3**

CO1	3		1
CO2		3	1
CO3	3	1	1
CO4	2	3	
CO5	3	2	
Average CO	**3**	**2**	**1**

Text Books & References

1 Dr.Eranna Dr.S Vasudevamurthy, "**Department manual-M3**", Second Edition, Choose an item.,

Web Links.

1 Study of Impulse Generator:http://vlabs.iitkgp.ernet.in/vhv/exp1/index.html/ /

2 3 Stage Cockroft Walton's DC voltage multiplier circuit:

http://vlabs.iitkgp.ernet.in/vhv/exp10/index.ht

Note 1: 20% program or experiments through virtual lab or any other online platform

Subject Title : POWER SYSTEM SIMULATION LABORATORY

Sub.Code:EEL75 No. of Credits:1.5=0:0:1.5 (L - T – P) No. of Lecture Hours/Week : 03
Exam Duration:3 Hrs CIE +SEE=50+50=100 Total No.of Contact Hours:39

Course Learning Objectives:

1. Develop skills of using computer packages like MATLAB (coding and SIMULINK) in Power system studies.
2. Develop skills of using Mi Power package for designing and analysis of electrical power networks , apply and investigate typical case study problems.
3. Develop skills to make use of Virtual lab resources to implement and investigate power system studies.
4. Develop to make use of Open source software MATPOWER to analyse, the designed power system problems .
5. Develop skills to make use of virtual lab resources for out of class learning

Expt No	Experiments	No.of Hours	Blooms Taxnomy level.
1	Using MATLAB, (i) Y-bus formation for power system without mutual coupling by singular transformation & (ii) inspection method.	02	L1, L2, L3, L4
2	Using MATLAB, determination of bus currents, bus power and line flows for a specified system voltage (bus) profile.	02	L1,L2,L3.
3	Using MATLAB- power angle Characteristics for (i) salient and (ii) non-salient pole synchronous machines. Determination of reluctance power, excitation emf and regulation.	02	L1, L2, L3,L4,
4	Using MATLAB, Optimal generator scheduling for thermal power plants.	03	L1, L2, L3, L4
5	MATLAB, Program for Plotting swing curve when the fault is cleared.	03	L1, L2, L3, L4,L5
6	MATLAB Program for Plotting Swing curve for sustained fault and determination of critical clearing angle & time.	03	L1, L2, L3, L4,L5
7.	Using MATLAB- Gauss Seidel method for Load flow Analysis for the given power system.(3 Bus system only PQ bus)	03	L1, L2, L3, L,
8.	Using MATLAB- Formation of Jacobian for a system not exceeding four buses (no PV buses)	03	L1, L2, L3, L4,
9	Using MI-Power, Optimal generator scheduling for thermal power plants.	03	L1,L2,L3.
10	Using MI-power, Load flow analysis for (i) three bus (ii) five bus system using Gauss Seidal and Newton Raphson method.	03	L1, L2, L3, L4,L5

Expt No	Experiments	No.of Hours	Blooms Taxnomy level.
11	Using MI-Power, Unsymmetrical fault Analysis for the given system for the following types (i) SLGF, (ii) DLGF and (iii) LLF.	.	L1, L2, L3, L4,L5,L6
12	Plotting Power angle characteristics for the given synchronous machines(Salient and Non salient pole type)using MI Power	.	L1, L2, L3, L4,L5
13	Using MATPOWER open source software create , analyse and evaluate the given power system problem	Choose an item.	L1, L2, L3, L4,L5

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only.

Course Outcomes:

CO1	Recall Power system parameters and interpret the same to experiment with software packages (Mat lab/MI Power/MAT POWER-open source software) .
CO2	Develop programs and models using computer based tools for analyzing optimal generator scheduling and solve theoretically to verify the same.
CO3	Create, Analyse and develop different types of faults for stability studies and solve theoretically to verify the same.
CO4	Determine Load flow parameters using numerical methods and solve theoretically for verification.
CO5	Devise programs analyses to solve real time problems.

Course outcomes Mapping with programme outcomes

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	1,2,3	2	3		2	1					3	2		
2.	CO2	3,4,5	6	3	2	2						3	2		
3.	CO3	3,5,6	6	3			1					3	2		
4.	CO4	3,4,5	6	3								3	2		
5.	CO5	3,4,5,6	6	3		2	1					3	2		
Average CO				3	2	2	1					3	2		

Course Outcomes with PSOs

Sl.No	CO	PSO1	PSO2	PSO3
1	CO1	3	2	
2	CO2	3		
3	CO3	3	2	
4	CO4	3		
5	CO5	3	2	
Average CO		3	2	

Text Books.

1 PRDC, "User Manual".2018
2 Nalini S, T B Dayananda, "EEE Department Manual", 2018
3 Desmond J Higham**,** "MATLAB Guide", Third edition, Manchester,2005

Web Links.

1 www.prdcinfotek.com

2 www.mathworks.com

3. https://www.youtube.com/watch?v=6XMGzJa6HWc

4. https://www.youtube.com/watch?v=SIE-T67Y3-E

Note 1: Programming to be done using MATLAB/MI Power any versions. Specified Problems shall be done using open source software MAT Power.

Subject Title : Computer Aided Electrical Drawing

Sub.Code: EED76 | No. of Credits:03=2:0:1 (L - T – P) | No. of Lecture Hours/Week : 02

Exam Duration:03 Hrs | CIE+Assignment +SEE=50+00+50 | Total No.of Contact Hours:39

Course Learning Objectives:

1. To learn the various kinds of armature winding used in DC machines.
2. To learn the various kinds of armature winding used in AC machines.
3. To learn the arrangement of the entire winding in the armature.
4. Assemble drawing showing, how the different parts fit together and provide sufficient information to enable the assembly of a component.
5. Sectional views showing how parts fit and expose hidden details, clearly in the simplest way.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Introduction	03	L1,L2
2	Single layer Lap and Wave windings	03	L2-L3
3	Double layer Simplex Lap and Wave windings	03	L2-L3
4	Double layer duplex Lap and Wave windings	03	L2-L3
5	Equalizers and dummy coils	03	L2-L4
6	Integral and Fractional slot double layer Lap windings, short pitch ac windings	03	L2-L4
7	Integral and Fractional slot double layer Wave windings, short pitch ac windings	03 03	L2-L4
8	Hemitropic Un-bifurcated 2 and 3 tier windings, Bifurcated 2 and 3 tier windings, mush type windings.	03	L3-L5
9	Transformers sectional views of a limb and core type single phase and three transformers	03	L3-L5
10	Single phase Shell type transformers sectional views	03	L3-L5
11	Synchronous Machines: Sectional views of Rotor and stator.	03	L3-L5
12	D.C. machine: sectional views of a pole, yoke & field assembly, armature and commutators dealt separately*	03	L3-L5
13	Sectional views stator and rotor of Induction Machine*	03	L3-L5

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only

Note 2: * Drawings beyond the syllabus

Course Outcomes:

CO1 Students will be able to define and calculate the winding pitches of armature windings
CO2 Students will be able to develop various armature winding patterns DC machines
CO3 Students will be able to develop various armature winding patterns AC machines
CO4 Ability to analyse and assemble the various parts of the transformers
CO5 Ability to analyse and assemble the various parts of the synchronous machines

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.	CO1	2	08	3	3	1	2				2		2		2
2.	CO2	2	08	3	3	1	2				2		2		2
3.	CO3	2	08	3	3	1	2				2		2		2
4.	CO4	4	0\8	3	3	1	2				2		2		2
5.	CO5	5	08	3	3	1	2				2		2		2
Average CO				3	3	1	2				1		2		1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1
CO4		2	1
CO5	3	2	
Average CO	**3**	**2**	**1**

Text Books.

1 M. G. Say, “”Performance & Design of Alternating Current machines”, 3rd Edition, , CBS publishers, , 2002

2 A.E Clayton & N.N .Hancock , “The Performance & Design of DC machines”, 3rd Edition, CBS Publication,2004

3 A K Sawhney, “Electrical Machine Design”, 4th edition, Dhanpathraj and Sons, 2016

4 Enter Dr.Indrani MS, Shankarlal & Beaula D, name, “CAD for Electrical Engineers ”, 2nd, Singuine Technical Publishers, 2015

5 SF Developer, “Electrical Drafting”, 8th Edition, Eastern Book Promoters, 2010

Web Links.

1 https://www.academia.edu/22528348/COMPUTER_AIDED_ELECTRICAL_DRAWING_CAED_10EE65_Winding_Diagrams_i_DC_Winding_diagrams_ii_AC_Winding_Diagrams

2 https://www.researchgate.net/publication/241701467_AC_Winding_Analysis_Using_a_Winding_Function_Approach

3 https://www.diva-portal.org/smash/get/diva2:313895/FULLTEXT02.pdf

Subject Title : FLEXIBLE A.C. TRANSMISSION SYSTEMS (FACTS)

Sub.Code: EE731 No. of Credits:04=04:0:0 (L - T – P) No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs CIE+Asmt +SEE=45+5+50=100 Total No.of Contact Hours:52

Course Learning Objectives:

1. To understand the important parameters which play a vital role in power transmission.
2. To learn the concept of compensations required for a power system and the method of compensations implemented.
3. Emphasize the importance of the voltage and reactive power control in electrical systems
4. State different compensation techniques through FACTS devices
5. Analyse the real and reactive power flow and control in transmission lines

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**FACTS, Concepts and General System Configuration:** Power Transmission, interconnection, flow of power in ac system, power flow and dynamic stability consideration of a transmission interconnection, relative importance of controllable parameters, and basic types of facts controllers, shunt, series, combined shunt and series connected controllers. TEXT 1 and Reference Book 2	10	L1,L2,L3.
2	**POWER SEMICONDUCTOR DEVICES:** Types of high power devices, principle of high power device characteristics and requirements, power device material, diode, MOSFET, MOS Turn Off Thyristor, Emitter Turn OFF Thyristor, Integrated Gate Commuted Thyristor (GCT & IGCT). TEXT 1 and Reference Book 2	10	L1,L2,L3.
3	**a) VOLTAGE SOURCED CONVERTERS:** basic concepts, single-phase full wave bridge converter operation, a single-phase bridge converter and 3-phase full wave bridge converter for square wave harmonics. **b) SELF AND LINE COMMUTATED CURRENT SOURCE CONVERTER:** Basic concepts, 3 phase full wave rectifier, thyristor based converter, current sourced converters with turnoff devices, and current source converters versus voltage source converters. TEXT 1 and Reference Book 2	12	L1,L2,L3.
4	**STATIC SHUNT COMPENSATORS SVC AND STATCOM**: Objective of shunt compensation, methods of controllable VAR generation, static VAR compensator, SVC and STATCOM, comparison between SVC and STATCOM. TEXT 1 and Reference Book 2	10	L1,L2,L3.

5	**STATIC SERIES COMPENSATORS:** GCSC, TSSC, TCSC and SSSC, objectives of series compensation, variable impedance type of series compensation, switching converters, types, series compensation, external control for series reactive compensators. TEXT 1 and Reference Book 2	10	L1,L2,L3.

Note1: Unit 1 to 5 will have internal choice

Note2: a)Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4

b) Group Activity for 5 marks has to be evaluated through PPT presentation/ Subject quiz/ Project/ Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1. Transmission network of a power system and its peripheral parameters of control.
CO2. Brief Introduction of power devices and its characteristics to aid the control of power system parameter.
CO3. Different configuration of Converter systems.
CO4. The concept of shunt compensation and to implement in a power system
CO5. The concept of series compensation and to implement in a power system

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10		2	3			1						1
2.	CO2	2	11	3	2								1		1
3.	CO3	2	12	3	2	3	2	2		3			1		3
4.	CO4	4	10	3	3	3	2	2		2			3		2
5.	CO5	5	11	3	2	3	2	3		3			3		2
Average CO				3	2	3	2	1	1	2			2		2

Course Outcomes Mapping to Programme Specific Outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	3		
CO2		2	
CO3			

CO4			1
CO5	3	2	
Average CO	**3**	**2**	**1**

Text Books.

1 N.G.Hungorian & Laszlo Gyugyi, "Understanding Facts - Concepts and technology of flexible AC Transmission system", edition IEEE Press, standard publisher, 2001

Reference Text Books.

1 S.Rao, "EHV - AC, HVDC Transmission & Distribution Engineering", 3rd edition, Khanna publishers, 2003

2 K.R. Padiyar, "FACTS - Controllers in Power Transmission distribution", edition, New age publishers, 2007.

Web Links.

1 ttps://www.ebooks.com/en-af/book/418812/facts-controllers-in-power-transmission-and-distribution/k-r-padiyar/

2 http://research.iaun.ac.ir/pd/bahador.fani/pdfs/UploadFile_6422.pdf

Subject Title : ENERGY AUDITING & DEMAND SIDE MANAGEMENT

Sub.Code: EE732 No. of Credits:04=04:0:0 (L - T – P) No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs CIE+Assignment +SEE=45+5+50=100 Total No.of Contact Hours:52

Course Learning Objectives:

1. To enable the students to develop managerial skills to assess feasibility of alternative approaches and drive strategies regarding energy conservation and energy auditing
2. To facilitate the students to achieve a clear conceptual understanding of energy economic analysis.
3. To recognize opportunities for increasing rational use of energy and basics of energy auditing with application on different sectors.
4. To explain electrical load management techniques, harmonics and their effects, electricity tariffs and power factor improvement
5. To understand basics of demand side management and mechanisms (technical, legal or financial) that influence energy consumption

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**INTRODUCTION:** Energy Situation – World and India, Energy Consumption, Conservation, Codes, Standards and Legislation. TEXT 4 and TEXT 2. Reference Book	10	L1, L2
2	**ENERGY Economic Analysis:** The Time Value of Money Concept, Developing Cash Flow Models, Payback Analysis, Depreciation, Taxes and Tax Credit – Numerical Problems. TEXT 4 and TEXT 1. Reference Book	10	L1,L2,L3,L4
3	**ENERGY Auditing:** Introduction, Elements of Energy Audits, Energy Use Profiles, Measurements in Energy Audits, Presentation of Energy Audit Results. ELECTRICAL System Optimization: The Power Triangle, Motor Horsepower, Power Flow Concept. TEXT 4 and TEXT 1. Reference Book-4	12	L1,L2,L3.
4	**Electrical Equipment and power factor** –Correction & Location of Capacitors, Energy Efficient Motors, Lighting Basics, Electrical Tariff, Concept of ABT. TEXT 4 and TEXT 3, Reference Book	10	L1,L2,L3.

5	**Demand Side Management:** Introduction to DSM, Concept of DSM, Benefits of DSM, Different Techniques of DSM – Time of Day Pricing, Multi-Utility Power Exchange Model, Time of Day Models for Planning, Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Management and Organization of Energy Conservation Awareness Programs. TEXT 4 and TEXT 2. Reference Book-3	10	L1,L2,L3.

Note 1: Unit 1 to 5 will have internal choice

Note2: a)Two assignments are evaluated for 5 marks: Assignment -1 from Units 1,2 and 3. Assignment -2 from Units 3, 4 and 5

b) Group Activity for 5 Marks has to be evaluated through PPT presentations/Subject Quiz/Projects/Seminar.

Out of 5 Units, Unit 4is a Webinar unit conducted through Google Classroom/ Zoom/Cisco-WebEx.., and will be delivered by subject faculty.

Course Outcomes:

CO1	Conceptual knowledge of the technology, economics and regulation related issues associated with energy conservation and energy auditing in India and world Scenarios.
CO2	Ability to analyse the Energy Economic analysis and develop cash flow models.
CO3	Study methods of energy accounting and energy auditing in energy sector, industry and final consumption. Finding opportunities to increase the rational use of energy.
CO4	Study of Electric Equipment and Power factor Correction methods
CO5	Familiarize with Demand side management, especially with management in energy sector engineering and Fundamentals of product strategy management.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	07	3	1		2		2		2		2	2	2
2.	CO2	2	08	3	3	1	2		2		2	1	2	2	2
3.	CO3	2	12	3	3	1	2	1	2		2	1	2	2	2
4.	CO4	4	10	3	3	1	2	1	2		2	1	2	2	2
5.	CO5	5	15	3	2	1	2		2		2	1	2	2	2
Average CO				3	2	1	2	1	2		2	1	2	2	2

Course Outcomes Mapping to Programme Specific Outcomes:

Course Outcome	PSO1	PSO2	PSO3
CO1	3	2	1
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3
Average CO	3	2	3

Text Books.

1 Arry C. White, Philip S. Schmidt, David R. Brown, "Industrial Energy Management Systems", First Edition, Hemisphere Publishing Corporation New York, year

2 Albert Thumann, "Fundamentals of Energy Engineering", edition, Prentice Hall Inc, Englewood Cliffs, New Jersey.
, year

3 A S. Pabla, "Electrical Power distribution", 5th Edition, TMH, 2004

4 Ajjanna, "Energy auditing and demand side management", edition, Gouthami publications,Shimaoga, year

Reference Text Books.

1 D.P.Sen, K.R.Padiyar, IndraneSen, M.A.Pai, "Recent Advances in Control and Management of Energy Systems", Edition, Interline Publisher Bengaluru, 1993

2 Ashok V. Desai, "Energy Demand – Analysis, Management and Conservation", Wiley Eastern, publisher, 2005

3 Jyoti Prakash, "Demand Side Management", Wiley Interscience, TMH publisher, year

4 TERA, "Hand book on Energy Auditing", Tata Energy Research Institute, publisher, year

Web Links.

1 www.nptel.com

Subject Title : POWER SYSTEM DYNAMICS AND STABILITY

Sub.Code: EE733	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt +SEE=45+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1. Introduction to basic concepts of power system dynamics and stability. Review of classical methods, system modeling, and dynamics of synchronous generator.
2. Types of excitation and controllers, prime mover controllers, SMIB.
3. To study modeling of prime movers.
4. To study load modeling.
5. To study transient stability evaluation.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**a) Introduction:** Basic concepts of power system dynamics and stability. Review of classical methods. **b) System modeling and dynamics of synchronous generator:** modeling of synchronous machine, swing equation, park's transformation – park's voltage equation, park's mechanical equation (torque). Applications – (a) voltage build up in synchronous machine, and (b) Symmetrical short circuit of generator. TEXT 1 and TEXT 2. Reference Book 1	12	L1,L2,L3.
2	**Excitation and prime mover controllers:** Introduction, types of excitation, AVR with and without ESS, TGR, amplifier PSS, static exciters. TEXT 1 and TEXT 2. Reference Book 2	10	L1,L2,L3.
3	**Modeling of prime movers:** Introduction, three major components, block diagram, hydraulic turbine, and steam turbine. TEXT 1 and TEXT 2. Reference Book 2	10	L1,L2,L3.
4	**Load modeling:** Introduction, polynomial model and exponential model. Small signal angle stability: small signal angle stability with SMIB system, detailed model of SMIB. TEXT 1 and TEXT 2. Reference Book 3	10	L1,L2,L3.
5	**Transient stability analysis:** Simulation for transient stability evaluation, transient stability controllers. TEXT 1 and TEXT 2. Reference Book 3	10	L1,L2,L3.

Note 1: Unit 1 to 5 will have internal choice

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.

Note2:

a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

b) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project/Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco WebEx etc. and will be delivered by subject faculty.

Course Outcomes:

CO1	Understand and analyse model the synchronous generator under dynamic condition.
CO2	Analyse problems related to excitation system and prime mover controllers of synchronous generator.
CO3	Analyse and understand electrical load for different stability studies.
CO4	Apply simulation techniques for analysis of transient stability studies.
CO5	Evaluate the condition of stability of power system using different methods

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10	3	3		3						2		
2.	CO2	2	10	3	3		3						2		
3.	CO3	2	12	3	3		3						2		
4.	CO4	4	12	3	3		3	3					2		
5.	CO5	5	8	3	3		3						2		
Average CO				3	3		3	3					2		

Course Outcomes Mapping with Programme System Outcomes.

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1
CO2	3	2	1
CO3	3	2	1

CO4	3	2	1
CO5	3	2	1
Average CO	**3**	2	**1**

Text Books.

1 Padiyar K.R, "Power System Dynamics, Stability and Control", Second Edition, Interline Publications, 2006

2 Prabha Kundur, "Power System Stability and Control", 9th reprint, TMH publisher.

Reference Text Books.

1 MarijaIlic; John Zaborszky, "Dynamics and Control of Large Electric Power Systems", edition, IEEE Press and John Wiley & Sons, 2007

2 Paul M. Anderson and A. A. Fouad, "Power System Control and Stability Revised Printing", revised printing, IEEE Press and John Wiley & Sons, 2002.

3 Uma Rao, "Selected topics from IEEE Transaction and Conference Proceedings Computer Techniques in Power System", IK International Publishing House pvt. Ltd.

Web Links.

1 https://www.youtube.com/watch?v=TLoT0lSOVZk

2 https://courses.engr.illinois.edu/ece576/sp2018/Sauer%20and%20Pai%20book%20-%20Jan%202007.pdf

Subject Title : FUZZY LOGIC

Sub.Code: EE734 No. of Credits:04=04:0:0 (L - T – P) No. of Lecture Hours/Week : 04

Exam Duration:03 Hrs CIE+Asmt +SEE=45+5+50=100 Total No.of Contact Hours:52

Course Learning Objectives:

1. Understand the basic of fuzzy sets.
2. Learn fuzzy logic inference with premise on fuzzy proposition
3. Study fuzzy linear and non –linear controller design
4. Provide an insight into structure and design of adaptive controller.
5. Apply fuzzy inference in the area of process control and real time applications.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**THE MATHEMATICS OF FUZZY CONTROL:** Fuzzy sets, properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, the extension principle. TEXT 1 and TEXT 2. Reference Book 1	10	L1,L2,L3.
2	**THEORY OF APPROXIMATE REASONING:** Linguistic variables, Fuzzy proportions, Fuzzy if- then statements, inference rules, compositional rule of inference. TEXT 1 and TEXT 2. Reference Book 1	10	L1,L2,L3.
3	**NON-LINEAR FUZZY CONTROL:** FKBC as a linear transient element, PID like FKBC, sliding mode FKBC, Sugeno FKBC. TEXT 1 and TEXT 2. Reference Book 1,2	10	L2,L3,L4
4	**FUZZY KNOWLEDGE BASED CONTROLLERS (FKBC):** Basic concept structure of FKBC, choice of membership functions, scaling factors, rules, fuzzyfication and defuzzyfication procedures. Simple applications of FKBC (washing machines, traffic regulations, lift control, aircraft landing Control etc.). TEXT 1 and TEXT 2. Reference Book 1	11	L2,L3,L4
5	**ADAPTIVE FUZZY CONTROL:** Process performance monitoring, adaption mechanisms, membership functions, tuning using gradient descent and performance criteria. Set organizing controller model based controller. TEXT 1 and TEXT 2. Reference Book 1,2	11	L2,L3,L4

Note 1: Unit 1 to 5 will have internal choice

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.

Note2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

Note:3 Out of 5 Units, Unit 4is a Webinar unit conducted through Google Classroom/ Zoom/Cisco-Webex.., and will be delivered by subject faculty.

Course Outcomes:

CO1	Able to distinguish between the crisp set and fuzzy set concepts.
CO2	Define fuzzy sets using linguistic variables and membership functions.
CO3	Analyse fuzzy propositions and fuzzy inference systems.
CO4	Apply fuzzy inference systems in the design of controllers..
CO5	Apply fuzzy logic in the area of process control & real time systems.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10		3	1	2				2		2		2
2.	CO2	2	10	3	3	1	2				2		2		2
3.	CO3	2	12	3	3	1	2				2		2		2
4.	CO4	4	12	3	3	1	2				2		2		2
5.	CO5	5	8	3	3	1	2				2		2		2
Average COs				3	3	1	2				2		2		2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcomes	**PSO1**	**PSO2**	**PSO3**
CO1	**1**	**2**	**1**
CO2	**1**	**1**	**1**
CO3	**1**	**2**	**1**
CO4	**3**	**2**	**3**
CO5	**3**	**2**	**3**
Average COs	**2**	**2**	**2**

Text Books.

1 Timothy Ross, “Fuzzy Logic With Engineering Applications”, Second Edition, John Wiley, 2009.

2 G. J. Klir and T. A. Folger, “Fuzzy Sets Uncertainty and Information”, PHI IEEE, 2009.

Reference Text Books.

1 D. Diankar, H. Hellen doom and M. Rein frank, “An Introduction to Fuzzy Control”, Narosa Publishers, India, 1996.

2 R. R. Yaser and D. P. Filer, “Essentials of Fuzzy Modeling and Control”, John Wiley, 2007.

3 Yen, “Fuzzy Logic Intelligence Control And Information”, First Edition, Pearson education, 2006

Web Links.

1 Prof. Nilladri Chaterjee, ”Introduction to Fuzzy Set Theory, Arithmetic and Logic”,IIT Delhi

2 Fuzzy Sets, Logic and Systems & Applications : https://nptel.ac.in/courses/111/102/111102130/

Subject Title : ARTIFICIAL NEURAL NETWORK

Sub.Code:EE735 No. of Credits:04=04:0:0 (L - T – P) No. of Lecture Hours/Week :04

Exam Duration:03 Hrs CIE+Asmt +SEE=45+5+50=100 Total No.of Contact Hours:52

Course Learning Objectives:

1. To organize the structural components.
2. Computation methodology needed for information extraction and storage.
3. Perform computation through learning algorithms
4. To analyse the model and networks
5. Optimization techniques.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Introduction, history, structure and function of single neuron, Neural net architectures, neural learning, use of neural networks. Supervised learning, single layer networks, perceptron's, linear separability, perception training algorithm, guarantees of success, Modifications. TEXT1, TEXT2, REFERENCE 1	10	L1,L2,L3
2	**Multiclass Networks**: Multilevel discrimination, back propagation, setting parameter values, theoretical results. Accelerating learning process, application, and Madeline adaptive multilayer networks. TEXT1, TEXT2, REFERENCE 1	12	L1,L2,L3
3	**Prediction networks:** Radial basis functions, polynomial networks, regularization, unsupervised learning, winner-take-all networks. Learning vector quantizing, counter propagation networks, adaptive resonance theorem, topologically organized networks, distance based learning, recognition. TEXT1, TEXT2, REFERENCE 2	12	L1,L2,L3
4	**Associative models:** Hop Field networks, brain state networks, Boltzmann machines, hetero associations. TEXT1, TEXT2, REFERENCE 3	09	L1,L2,L3
5	**Optimization**: Hopfield networks, simulated annealing, random search, evolutionary computation.	09	L1,L2,L3

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Introduction, history, structure and function of single neuron, Neural net architectures, neural learning, use of neural networks. Supervised learning, single layer networks, perceptron's, linear separability, perception training algorithm, guarantees of success, Modifications. TEXT1, TEXT2, REFERENCE 1	10	L1,L2,L3
	TEXT1, TEXT2, REFERENCE 3		

Note 1: Unit 1 to 5 will have internal choice

Note2: a)Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5 and
b)Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/ Zoom/Cisco-WebEx.., and will be delivered by subject faculty.

Course Outcomes:

CO1	Need of neural networks and its various realizations
CO2	Analysis of neural networks various functional blocks with multiple inputs and outputs information
CO3	Programming issues with application of neural networks to single input single output system.
CO4	.Application of neural networks to multi input multi output system
CO5	Salient features of input data mining and Realization of Hybrid systems

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	L1,L2,L3	8	3	1	1	2								
2.	CO2	L1,L2,L3	8	3	2	2	1							1	
3.	CO3	L1,L2, L3	7			3	2						2	1	**1**
4.	CO4	L1,L2,L3	8	2	1							2		1	**1**
5.	CO5	L1,L2,L3	8				3	2		2				1	1
Average COs				3	1	3	3	2		2		2	2	1	1

Course Outcomes Mapping with PSOs

Sl.No	Course Outcome	PSO1	PSO2	PSO3
1.	CO1		2	3
2.	CO2		2	3
3.	CO3		2	3
4.	CO4		2	3
5.	CO5		2	3
Average CO			2	3

Text Books.

1 R, Schalkoff, "Artificial Neural Networks,", 1st Edition, Tata Mc Graw Hill, 1997

2 C.K. Mohan and Sanjay Ranka, "Elements of Artificial Neural Networks", 1st Edition, MIT Press, - Penram International Publishing, 1997

Reference Text Books.

1 Hagan, Demuth and Beale Cengage, "Neural Network Design", 2nd Edition, Martin T. Hagan, 1996

2 Zurada, Jacek M, "Introduction to artificial neural systems", 1st Edition, Jaico Publishing House, 1994

3 B.Yegnanarayana, "Artificial Neural Networks", 2nd edition, PHI Publisher, 2009

4 Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms and Applications", 1st Edition, Pearson Publisher, 2004

5 Věra Kůrková & Yannis Manolopoulos, "Artificial Neural Networks and Machine Learning", 1st Edition, Springer, 2018

Web Links.

1 https://onlinecourses.nptel.ac.in. ·www.udemy.com/

2 ·www.udemy.com/

3 https://www.xenonstack.com/blog/artificial-neural-network-applications/

Subject Title : ELECTRICAL POWER QUALITY

Sub.Code:EE736	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt +SEE=45+05+50=100	Total No.of Contact Hours:52

Course Learning Objectives: After the completion of the course the students should be able to

1 Understand the causes of power quality (PQ) and effects of PQ problems, requirement of PQ improvements, and mitigation aspects of PQ problems.

2 Explain the Q definitions, terminologies, standards, benchmarks, monitoring requirements through numerical problems.

3 Explain the passive shunt and series compensation using lossless passive LC components, active shunt compensation using DSTATCOM (distribution static compensators), active series compensation using DVR (dynamic voltage restorer), and combined compensation using UPQC (unified power quality compensator) for mitigation of current-based PQ problems.

4. Understand the methodology to improve the power quality for sensitive loads by various mitigating custom power devices;

5. Analyse the current and voltage related power quality issues;

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	Power Quality: An Introduction, State of the Art on Power Quality, Classification of Power Quality Problems, Causes of Power Quality Problems, Effects of Power Quality Problems on Users Power Quality Standards and Monitoring: Introduction, State of the Art on Power Quality Standards and Monitoring, Power Quality Terminologies, Power Quality Definitions, Power Quality Standards, Power Quality Monitoring TEXT 1 and TEXT 2. Reference Book1	11	L1,L2,L3.
2	Passive Shunt and Series Compensation: Introduction, State of the Art on Passive Shunt and Series Compensators, Classification of Passive Shunt and Series Compensators, Principle of Operation of Passive Shunt and Series Compensators, Analysis and Design of Passive Shunt Compensators, Modelling, Simulation, and Performance of Passive Shunt and Series Compensators, Numerical Examples. TEXT 1 and TEXT 2	11	L1,L2,L3.
3	Active Shunt Compensation: Introduction, State of the Art on DSTATCOMs, Classification of DSTATCOMs, Principle of Operation of DSTATCOM - Control of DSTATCOMs in UPF Mode of Operation, Design of a Three-Phase Three-Leg VSC-Based DSTATCOM. Numerical Examples.	10	L1,L2,L3.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	TEXT 1 and TEXT 2.		
4	Active Series Compensation: Introduction, State of the Art on Active Series Compensators, Classification of Active Series Compensators, Principle of Operation and Control of Active Series Compensators, Analysis and Design of Active Series Compensators, Numerical Examples. TEXT 1 and TEXT 2.	10	L1,L2,L3.
5	Unified Power Quality Compensators: Introduction, State of the Art on Unified Power Quality Compensators, Classification of Unified Power Quality Compensators, Principle of Operation and Control of Unified Power Quality Compensators, Numerical Examples. TEXT 1 and TEXT 2.	10	L1,L2,L3.

Note 1: Unit 1 to 5 will have internal choice

Note2: a)Two assignments are evaluated for10marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

b)Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit2is a Webinar Unit delivered through Google meet/Cisco Webex/Zoom and it will be delivered by Subject Faculty

Course Outcomes:

CO1	Explain causes, effects of PQ problems and classification of mitigation techniques for PQ problems
CO2	Explain PQ standards, terminology and monitoring requirements through numerical problems.
CO3	Explain passive shunt and series compensation using lossless passive components.
CO4	Explain the design, operation and modeling of active shunt and series compensation equipment.
CO5	Decide the compensators and filters to keep the power quality indices within the standards..

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				a	b	c	d	e	f	g	h	i	j	k	l
1.	CO1	**2**	**10**		**3**	**1**	**2**				**2**		**2**		**2**
2.	CO2	**2**	**10**	**3**	**3**	**1**	**2**				**2**		**2**		**2**

3.	CO3	**2**	**12**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
4.	CO4	**4**	**12**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
5.	CO5	**5**	**8**	**3**	**3**	**1**	**2**				**2**		**2**		**2**
			Average Outcome	**3**	**3**	**1**	**2**				**2**		**2**		**2**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	**PSO1**	**PSO2**	**PSO3**
CO1	3		
CO2		2	
CO3			
CO4			1
CO5	3	2	
Average CO	**3**	**2**	**1**

Text Books.

1 Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, “Power Quality Problems and Mitigation”, First Edition, John Wiley Sons PVT Ltd, 2015

2 Alexander Kusko and Marc T Thomson, “Power Quality in Electrical Systems”, First edition, McGraw Hill 2007

Reference Text Books.

1 Roger C Dugan, Mark F Mc Granaghan,SuryaSantose and H.Wayne Beaty “Electrical Power System Qulaity”,2nd edition, Mc Graw Hill publisher, 2017

Web Links.

1 Learning resource by nptel, http://nptel.ac.in/courses/108106025/ Power quality in power distribution systems, Dr. Mahesh Kumar, IIT Madras

Subject Title: Modern Power System Protection

Sub.Code: EE81 | No. of Credits:04=04:0:0 (L - T – P) | No. of Lecture Hours/Week : 04

Exam Duration:03 Hrs | CIE+Assmt +SEE=45+5+50=100 | Total No.of Contact Hours:52

Course Learning Objectives:

1. To introduce conventional and modern protection devices for power systems.
2. To understand the concept and working of Protection devices
3. To learn protection philosophy and embedded protection systems.
4. To understand Protection systems through Phasor measurement techniques.
5. To introduce different International Standards related to protective relaying.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**a) Fuses:** Introduction to fuse, fuse law, cut -off characteristics, Time current characteristics, fuse material, liquid fuse. **b)** Circuit Breakers – Operating principles: Introduction, requirement of a circuit breakers, basic principle of operation of a circuit breaker, properties of arc, initiation and maintenance of arc, arc interruption theories -slepian's theory and energy balance theory, **c) Circuits Breakers** – Types & Construction: SF6 breaker, Puffer and non-Puffer type of SF6 breakers. Vacuum circuit breakers - principle of operation and constructional details. Advantages and disadvantages of different types of Circuit breakers. TEXT 1 and TEXT 2. Reference 3	10	L1 -L4
2	**a) Protective Relaying Operating principles**: Requirement of Protective Relaying, Zones of protection, primary and backup protection, Essential qualities of Protective Relaying, Evolution of protective relays – Historical perspective, Classification of Protective Relays, A concise introduction to electromechanical relays **b) Protection philosophies:** Understanding of protection philosophies (the Physics of protection) as applicable to the unit protected - such as non-pilot over-current protection of transmission lines, transformer protection, non-pilot distance protection of transmission lines, rotating machinery protection. TEXT 1 and TEXT 2. Reference 3	10	L1 -L4
3	**Embedded Protection System:** General architecture & Essential requirements of an embedded protection system – metering, protection, automation and control	12	L1-L4

	modules; model/component based approach in designing an embedded system; choice of operating system, microprocessor architecture and digital signal processor architecture & requirements of – DMA, ADC, MAC, memory, communication controllers. Modeling formalism using UML – formal representation of requirements, temporal and spatial modeling techniques. Use of finite automata in designing of sequential control algorithm Reference 1 - 5		
4	Phasor measurement, metering and records (DSP techniques): Definition of a phasor; DSP primer: simultaneity in sampling, sampling theorem, aliasing, digital filters – FIR, IIR, symmetric FIR filters, design of high pass and low pass filters; Phasor measurement algorithm; Spectral leakage and frequency tracking algorithms; Introduction to synchro-phasor measurement. Reference 1 - 5	12	L1 -L4
5	Substation Automation Concepts & Communication stacks: Introduction to substation communication architecture; Quasi real time and real time communication requirements; Choice of physical layer based on the bandwidth requirements – RS-485, IEEE 802.3; Evolution of communication stacks and standards – MODBUS, IEC 60870-5-103, DNP 3.0, IEC 61850. A brief introduction to MODBUS; A brief introduction to IEC 61850. Reference 1 - 5	08	L1 -L4

Note 1: Unit 1 to 5 will have internal choice

Note 2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

Note 2: Out of 5 Units, Unit 4is a Webinar unit conducted through Google Classroom/ Zoom/Cisco-WebEx.., and will be delivered by subject faculty.

CO1 List and define various protection devices and protection schemes.

CO2 Explain the characteristics and working of various protective devices and protection schemes.

CO3 Apply the basic concepts of protection systems to solve problems related to protective relaying.

CO4 Analyse various protection devices and protection techniques for application to protection systems.

CO5 Justify the use and explain - various international standards related to protective Relaying

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12

1.	CO1	1,2	10	3	3						1				1
2.	CO2	1 - 4	10	3	3	1					1				1
3	CO3	1 - 4	12	3	3		2				1				1
4.	CO4	1 - 4	12	3	3	1	2	3			1				1
5.	CO5	1 - 4	08	3	3	1	2	3			1				1
Average COs				3	3	1	2	2			1				1

Course outcomes mapping with Program specific outcomes

Course Outcome	PSO1	PSO2	PSO3
CO1	1		
CO2	2		
CO3	3		
CO4		3	
CO5		1	
Average CO	**2**	**2**	

Text Books.

1 *Badri Ram & D.N.Vishwakarma , "Power System Protection and Switch gear", 15th reprint, Tata Mc Graw Hill publication, New Delhi, , 2004*

2 *Soni, Gupta & Bhatnagar , "A Course in Electrical Power", 13th Edition, Dhanapatrai publications, 2008*

Reference Text Books.

1 *Stanley.H.Horowitz & Arun.G.Phadke, "Power system relaying", 3rd edition, Wiley Eastern Publication,*

2 *Arun.G.Phadke & James.S.Thorp, "Computer relaying for power systems", 2 nd edition, Wiley Eastern Publication,*

3 *Bhutanese Oza, et.al , "Power system protection and switchgear", 2 nd edition, Tata Mc Graw Hill publication, New Delhi,*

4 *Y G. Painthankar and S R Bhide , "Fundamentals of Power System protection", 2 nd edition, PHI Learning Private Limited, New Delhi , 2009*

5 *PSRC, W I-01 report, "Applying microprocessor based technology applied to relaying",2009*

Web Links.

1 https://nptel.ac.in/

Subject Title: POWER SYSTEM OPERATION AND CONTROL

Sub.Code: EE82	No. of Credits:03=03:0:0 (L - T – P)	No. of Lecture Hours/Week : 03
Exam Duration:03 Hrs	CIE+Asmt+SEE=45+5+50=100	Total No.of Contact Hours:39

Course Learning Objectives:

1 To impart knowledge relevant to power system planning and operations and to explain components, architecture and configuration of SCADA.

2 To provide an insight into elaborate concepts of Automatic Generation control for Load frequency

3 To explain relation between voltage, power and reactive power at a node

4 To define unit commitment and explain various constraints in unit commitment and the solution methods.

5 Power system security issues and Contingency analysis.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Control centre operation of power systems:** Operating States of Power System, Objectives of Control, Key Concepts of Reliable Operation, Preventive and Emergency Controls Introduction to SCADA, control centre, digital computer configuration, automatic generation control, area control error, operation without central computers, parallel operation of generators. (Problems on parallel operation only) TEXT 1 and TEXT 2. Reference Book	09	L1,L2,L4
2	**Automatic Generation Control:** Introduction, Load Frequency Control (single area case) Turbine speed governing system Model of speed Governing system, Turbine model, Control area concept, Economic dispatch control, Two area load frequency control, and Automatic voltage regulator. TEXT 2 and Reference Book	08	L2,L3,L4
3	**Control of Voltage and reactive power:** Introduction, generation and absorption of reactive power, relation between voltage, power and reactive power at a node, Methods of Voltage Control, Dependence of Voltage on Reactive Power , Sensitivity of Voltage to Changes in P And Q single machine infinite bus system, methods of voltage control, sub synchronous resonance, voltage stability, voltage collapse. TEXT 4 and Reference Book	08	L2,L3
4	**Unit commitment:** statement of the problem, need and importance of Unit commitment, methods – priority list method, dynamic	7	L1,L2,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	programming method (Flow chart only), constraints, spinning reserve, examples. TEXT 3 and Reference Book		
5	**Power system security:** Introduction, system state classification, Security Levels of System, Functions of System Security analysis, factors affecting power system security, modeling for contingency analysis, contingency selection, contingency analysis, Linear sensitivity factors. TEXT 3 and Reference Book	7	L2,L3

Note 1: Unit 1 to 5 will have internal choice

Note2:

a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5
b) Out of 5 Units, Unit 4is a Webinar unit conducted through Google Classroom/ Zoom/Cisco-WebEx.., and will be delivered by subject faculty.

Course Outcomes:

CO1	Express Economic operation of power system and importance of SCADA
CO2	Explain the functions of Automatic generation control, speed governors and analyze load frequency control Techniques and also to explain issues of hydrothermal scheduling and solutions to hydro thermal problems.
CO3	Ability to analyze methods of voltage and reactive power control
CO4	Solve unit commitment problems.
CO5	Describe reliability, security, contingency analysis, state estimation and related issues of power and Discuss the Recent trends in PSOC.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12

1.	CO1	2	09		3	2	3	1	1		2	1	1		2
2.	CO2.	2	08	2	3	1	2	2			2	2	2	1	2
3.	CO3	4	08	2	3	1	2	2		3	2		2		2
4.	CO4	5	07	2	3	1	3	1		2	2		2	1	2
5.	CO5	3	07	3	3	1	3	3		3	2		2	2	2
Average CO				2	3	1	3	2		3	2	2	2	1	2

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		
CO2	2	2	1
CO3	1	1	
CO4			1
CO5	3	2	
Average CO	3	2	1

Text Books.

1 *G L Kusic, "Computer aided power system analysis", Second Edition, PHI, 2010. Choose an item.*

2 *I.J. Nagarath and D.P. Kothari, "Modern Power System Analysis", Second edition, TMH, 2003.*

3 *AJ Wood &Woolenburg, "Power Generation, Operation & control", 2nd edition, John Wiley & Sons, 2009*

4 *B.M Weedy and B J Cory, "Electric power Systems", 5th edition, Wiley, 2012. Choose an item.*

5 *Olle J Elgerd, "Electric Energy Systems", 2nd edition, TMH, 2008*

Reference Text Books.

1 *Prabha Kundur, "Power System Stability and Control", 3rd edition, TMH, 1993.*

2 *PSR Murthy, "Operation and control in Power Systems", 2nd edition, B S Publications, 1998.*

3 *Abhijit Chakraborty, Sunit Haldar, "Power system analysis, operation and Control", 2nd edition PHI, 2009*

4 *K. Uma Rao, "Power System Operation and Control", 1st Edition, Wiley, 2012*

5 *Robert H Miller & James H Malinowski, "Power System operation", 3rd edition, TMH, 2009*

Web Links.

1 www.nptel.com

Elective-F

Subject Title : Testing and Commissioning of Electrical Equipments

Sub.Code: EE831	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt+ SEE= 45+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1 Describe the process to plan, control and implement commissioning of electrical equipment's.

2 Differentiate the performance specifications of transformer and induction motor.

3 Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.

4 Identification of tools and equipment is used for installation and maintenance of electrical equipment.

5 Explain the operation of an electrical equipment's such as isolators, circuit breakers, insulators and switchgear.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Transformers:** **Specifications:**Power and distribution transformers as per BIS. Installation: Location site selection, foundation details, code of practice for terminal plates, polarity and phase sequence, oil tanks, drying of winding and general inspection.. TEXT1 and TEXT2 and REFERENCE 2	10	L1, L2
2	**Transformers: C**ommissioning tests as per national and international standards - volts ratio earth resistance, oil strength, insulation tests, impulse tests polarizing index, load temperature rise tests. specific tests for determination of performance curves like efficiencies, regulation etc., determination mechanical stress under normal and abnormal conditions Text book1		
3	**synchronous machines:** a)specifications: as per BIS standards. b)**installation** - physical inspection, foundation details, alignments, excitation systems, cooling and control gear, drying out. c) Commissioning tests - insulation, resistance measurement of armature and field windings, wave form and telephone interference tests, line charging capacitance.	11	L1,L2,L3.

	d) **Performance tests**: -various tests to estimate the performance of generator operations, slip test, maximum lagging current, maximum reluctance power tests, sudden short circuit tests, transient sub transient parameters, measurement of sequence impedances, capacitive reactance, and separation of losses, temperature rise test, and retardation tests. e) **Factory tests :-**gap length, magnetic eccentricity, balancing vibrations, bearing performance. 1. text1 and text 2. reference book: 2.		
3	**Synchronous Machines:** a)Specifications- for different types of motors, duty, IP protection. b) **Installation**- location of the motors and its control apparatus, shaft alignment for various coupling, fitting of pulleys and coupling, drying of windings. c) **Commissioning tests** -mechanical tests for alignment, air gap symmetry, tests for bearings, vibrations and balancing. d) Performance tests: Various tests to estimate the performance of generator operations, slip test, maximum lagging current, maximum reluctance test, sudden short circuits tests and subtransient parameters measurement of sequence impedance,capacitive reactance and separation of losses, temperature test and retardation tests e) factory tests: gap length magnetic eccentricity, balancing vibration, bearing performance TEXT1 and TEXT2, Reference Book: 2.	12	L1,L2,L3
4	**Induction Motors:** a) **Specifications:** for different types of motors, duty, IP protection b) **Installation:** location of motors,(including the foundation details) and its control operators, shaft and alignment for various coupling, fitting of pulleys and coupling, drying of windings c) **Commissioning test:** Mechanical test for alignment, for airgap symmetry, test for bearings, vibrations and balancing TEXT1 and TEXT2. Reference Book: 2.	10	L1,L2,L3
5	**Induction Motor** a) Electrical tests: Insulation test, Earth resistance, High voltage test, starting up, failure to speed up to take the load, types of tests, routine tests, factory test and site test. b) Specific test: performance and temperature rise test, stray load losses, shaft alignment, rerating and special duty capacity	11	L3,L4,L5

	Switchgear and Protective Devices: Standards, Types, Specification, Installation, Commissioning Tests, Maintenance Schedule, Type and Routine Tests. TEXT 1, TEXT3, Reference Book: 1 and 2.		

Note 1: Unit 1 to 5 will have internal choice

Note 2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty

Course Outcomes:

CO1	Describe the process to plan, control and implement commissioning of electrical equipment's
CO2	Differentiate the performance specifications of transformer and induction motor.
CO3	Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.
CO4	Describe corrective and preventive maintenance of electrical equipment's.
CO5	Explain the operation of an electrical equipment's such as isolators, circuit breakers, induction motor and synchronous machines

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	2	10		3	1	2				2		2		2
2.	CO2	2	10	3	3	1	2				2		2		2
3.	CO3	2	12	3	3	1	2				2		2		2
4.	CO4	4	12	3	3	1	2				2		2		2
5.	CO5	5	8	3	3	1	2				2		2		2
Average CO				3	3	1	2				2		2		2

Course Outcomes Mapping with Programme Specific Outcomes

Sl.No	Course Outcome	PSO1	PSO2	PSO3
1.	CO1	**3**	**2**	**1**
2.	CO2	**3**	**2**	**1**
3.	CO3	**3**	**2**	

4.	CO4	**3**	**2**	**1**
5.	CO5	**3**	**2**	**1**
Average CO		**3**	**2**	**1**

Text Books.

1 S Rao, “, Testing & Commissioning Of Electrical Equipment” -B .V. S. Rao, Media Promoters and Publication Pvt., Ltd,

2 R.L.Chakrasali, Testing and Commissioning of Electrical Equipment”, 1st Edition,2014, Prism Books Pvt Ltd, 2014

3 S.K.Sharotri K, “Preventive Maintenance of Electrical Apparatus”, 1 st Edition, 1980, Katson Publishing House.

Reference Text Books.

1 BHEL, “Handbook of Switchgears”, Ist Edition Mc GrawHIll, 2005

2 BHEL “Transformers”, Ist Edition McGraw-Hill, 2003

Web Links.

1 https://electrical-engineering-portal.com/commissioning-of-electrical-equipment

2 https://www.voltechgroup.com/img/icd1/profiles/Testing%20&%20Commissioning.pdf

Subject Title : HVDC TRANSMISSION

Sub.Code: EE832	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt +SEE= 45+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1 To learn the aspects of AC and DC transmission

2 To analyse the components required for HVDC transmission.

3 To learn the different converter configurations for HVDC transmission systems.

4 To analyse the performance of Converters.

5 To Understand the control characteristics and different protection schemes.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Introduction:** Historical sketch, constitution of EHV AC and DC links, comparison of AC and DC transmission systems-technical, economics and reliability, advantages and disadvantages of HVDC transmission systems, applications of DC transmission systems, Types of HVDC links, block diagram of HVDC system. TEXT 1 and TEXT 2. Reference Book-1	08	L1,L2,L3.
2	**Converter circuits:** Thyristor characteristics, description of uncontrolled rectifiers, controlled rectifiers: single phase rectifiers, three phase rectifiers, choice of best configuration for HV DC systems and two level voltage source inverter. TEXT 1 and TEXT 2. Reference Book-1	12	L1,L2,L3.
3	**Analysis of the bridge converter:** Analysis of six pulse converters with grid control and no overlap, Analysis of six pulse converters with grid control and overlap greater than and less than 60 degrees, analysis of twelve pulse converters complete characteristics of rectifier and inverter. TEXT 1 and TEXT 2. Reference Book-1	11	L3,L4,L5
4	**Control of HVDC converters and systems:** Grid control, basic means of control, power reversal, limitations of manual control, constant current versus constant voltage, desired feature of control, actual control characteristics, constant -minimum -ignition –angle control, constant –current control, constant –extinction –angle control, stability of control, tap changer control, power control. TEXT 1 and TEXT 2. Reference Book-1	12	L2,L3,L4
5	**Protection:** Introduction, DC reactor, surge arresters, over voltage protection, over current protection, voltage oscillations and valve dampers, current oscillations and anode dampers, DC	09	L2,L3,L4

	line oscillations and line dampers, clear line faults and reenergizing the line. TEXT 1 and TEXT 2. Reference Book-1		

Note 1: Unit 1 to 5 will have internal choice

Note2:

a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1,2 and 3. Assignment -2 from Units 3, 4 and 5

b) Group Activity for 5 Marks has to be evaluated through PPT presentations/Subject Quiz/Projects/Seminar

Note:3 Out of 5 Units, Unit 3 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Recall and compare the different power transmission systems.

CO2 Understand ideal requirements of HVDC transmission systems.

CO3 Analyses the different converter circuits and select the suitable converter circuit for HVDC systems.

CO4 Analyse controllers for HVDC systems.

CO5 Understand the importance of protection and its requirements for HVDC systems.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				a	b	c	d	e	f	g	h	i	j	k	l
1.	CO1	**2**	**08**	**3**	**1**	**2**			**1**	**1**	**1**		**1**		**2**
2.	CO2	**2**	**12**	**3**			**2**	**1**		**2**					
3.	CO3	**2**	**11**	**3**	**1**	**1**	**2**								
4.	CO4	**4**	**12**	**3**	**3**	**1**	**2**							**1**	**2**
5.	CO5	**5**	**09**	**3**		**1**	**2**		**2**	**2**				**1**	**2**
Average CO				**3**	**2**	**1**	**2**	**1**	**2**	**2**	**1**		**1**	**1**	**2**

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	**PSO1**	**PSO2**	**PSO3**

CO1	2		1
CO2	3	2	1
CO3	3	3	1
CO4	3	3	1
CO5	3	3	1
Average CO	**3**	**3**	**1**

Text Books.

1. *EW Kimbark, "Direct current Transmission", First Edition, Wiley Interscience, 1971*
2. *K.R.Padiyar, "High Voltage D.C.Power Transmission System", Second edition, New Age International Publishers Ltd., 2015*

Reference Text Books.

1. *Jos Arrillaga Y.H.Liu and Mevelle R Watson, "High Voltage Power Transmission: The HVDC Options", Second edition, The Institution of Electrical Engineers, 1998*

Web Links.

1. www.nptel.com

Subject Title : INSULATION ENGINEERING

Sub.Code: EE833	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Assmt +SEE=45+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1. To introduce concepts of dielectric, dielectric stress in various electrical equipment's.
2. To the Insulation systems in power system apparatus.
3. To introduce dielectric phenomena and breakdown strength of dielectric media - solid, liquid and vacuum.
4. To understand breakdown processes in gasses, GIS, surge arrestors and Insulation coordination.
5. To analyse failure of dielectrics due to ageing mechanism.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Electrostatic Field, their Control and Estimations:** Electric Field Intensity, Electric Strength, Classification of Electric Fields, Degree of Uniformity of Electric Fields, control of Electric field Intensity (stress control), Estimation of Electric Field Intensity, Basic Equations for potential and Field Intensity in Electrostatic Fields. TEXT 2 and 4 REFERENCE 1	11	L1, L2, L3
2	**Insulation System in Power System Apparatus:** Insulation system in capacitors, bushings and transformers. Modes of failure of insulation systems. Insulations used in rotating machines. TEXT 3 and 4, REFERENCE 1	09	L1, L2, L3
3	**Dielectric Phenomena:** Dielectric phenomena in insulation – Permittivity and Loss Tangent. Phenomena of Polarization, depolarization, Relaxation in solids and liquids. Breakdown strengths of Dielectric Media, Influence of type of electrical excitation (AC, DC and Impulse), Physics of breakdown phenomena in vacuum gaps. Concept of self-restoring and non self – restoring insulation, enclosed and exposed insulation. TEXT 3 and 4, REFERENCE 1	11	L1, L2, L3
4	**Gaseous Insulation**: Requirement of gaseous insulation. Breakdown processes: types of collision, Elastic and in-elastic, collision cross-section, Mobility of ions, Diffusion of charges, Emission of radiation and excitation, various secondary processes, Gas insulated substations. Overvoltage, Surge arrestors and insulation coordination. TEXT 2 – 4, REFERENCE 1	10	L1, L2, L3

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
5	**Ageing Phenomena:** Failure of electric insulation due to ageing. Ageing mechanisms - Thermal ageing, Electrical ageing, combined thermal and electrical ageing. Analysis of insulation failure data, Power law model, Graphical estimation of power law constants, ageing data. TEXT 1, REFERENCE 1	11	L1, L2, L3, L4

Note 1: Unit 1 to 5 will have internal choice

Note 2: a) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

Note:3 Out of 5 Units, Unit 5 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	To present their knowledge on Electric field and Solve electric field problems related to dielectrics.
CO2	To understand and analyse insulation/insulation systems used in power system apparatus.
CO3	To understand the dielectric phenomena in insulation and influence of excitations.
CO4	To understand the concept of gaseous insulation, insulation coordination and influence of over voltages.
CO5	Understand and analyse failure of insulation due to ageing.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	CO1	1	11	3	2		1								1
2.	CO2	2	09	3	3		2								1
3.	CO3	4	11	3	3		2								1
4.	CO4	5	10	3	3		2								1
5.	CO5	5	11	3	3		3								1
Average CO				3	3		2								1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3	1	
CO2	3	1	
CO3	3		

CO4	3		
CO5	3	1	
Average CO	**3**	**1**	

Text Books.

1 *Hann N.R. Schafer R.E. and Singapore wall N.D. John Wiley and sons, New York, 2002., "Methods of statistical analysis and life data.", , New york, 2002*

2 *E. Kufell and W.S. Zaengl, and J. Kufell, "High voltage Engineering fundamentals.", 2nd edition, Elsevier, 2005*

3 *M.S. Naidu and V Kamaraju,, "High voltage Engineering", 4th edition, TMH, 2008*

4 *Bradwell A. Peter, "Electrical insulation Peregrinus Ltd, London, 1993*

Reference Text Books.

1 *Ravindra Arora, Wolfgang Mosch, "High Voltage Insulation Engineering", , New age International Publishers Ltd,*

2 *J.M. Meek and J.D. Craggs, "Electrical breakdown of gases", Oxford university press,1953*

3 *Nasser E. John Wiley Interscience, "Fundamentals of gaseous ionization and plasma electronics", Newyork,1991*

4 *M.S. Naidu, "Gas Insulated Substations", I K International Publishing House,2008*

5 *Department of High voltage Engineering, Indian Institute of Science, "STTP Lecture notes on Electrical Insulation System Design", Department of High voltage Engineering, Indian Institute of Science, Bengaluru,1981*

Web Links.

1 https://www.insulation.org

Subject Title : ARTIFICIAL INTELLIGENCEAPPLICATIONS TO POWER SYSTEMS

Sub.Code: **EE834**	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Assignment +SEE=45+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1 To give knowledge about Sparsity oriented Programming

2 This course is an introduction to the basic concepts of Artificial Intelligence, with illustrations of current state of the art research and applications.

3 To have knowledge representation for the engineering issues underlying the design of AI systems.

4 To have a basic proficiency in a traditional AI language including an ability to write simple to intermediate programs and an ability to understand code written in that language.

5 To and blind and heuristic search, as well as an understanding of other topics such as minimax, resolution, etc. that play an important role in AI program.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Sparsity oriented Programming**: Introduction, physical structure and sparsity, pivoting, conservation of sparsity by optimal ordering of buses, schemes for ordering, UD table storage scheme. TEXT 2.	09	L1,L3
2	**Artificial Intelligence:** What is AI? Definitions, history and evolution, essential abilities of intelligence, AI applications; Problem solving: problem characteristics, problem search strategies, forward and backward reasoning, AND-OR graphs, game trees, search methods- informed and uninformed search, breadth first search and depth first search methods TEXT 1 and Reference 2	09	L1,L2
3	**Knowledge representation**: logical formalisms: propositional and predicate logic: syntax and semantics, wffs, clause form expressions, resolution- use of RRTs for proofs and answers, examples from electric power systems, Non-monotonic logic: TMS, modal, temporal and fuzzy logic. TEXT 1 and Reference3	12	L1,L3,L4
4	**a) Structured representation** of knowledge: ISA/ISPART trees, semantic nets, frames and scripts, examples from electric systems.	12	L3,L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	b) Expert systems: Basic components, forward and backward chaining, ES features, ES development, ES categories, ES tools and examples from electric drive systems. TEXT 1 and Reference 3		
5	**AI languages:** LISP and ProLog - Introduction, sample segments, Lisp primitives, list manipulation functions, function predicates, variables, iteration and recursion, property lists, sample programs for examples from electric power systems. TEXT 1 and Reference 4	10	L2,L3,L4

Note 1: Unit 1 to 5 will have internal choice

Note2: Two assignments are evaluated for marks: Assignment 5 -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

Note:3 Out of 5 Units, Unit 4 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1 Understand the basic issues of knowledge representation of Sparsity oriented programming.

CO2 Apply basic knowledge of AI to solve simple problems

CO3 Learn about knowledge representation on logical formalisms

CO4 Promote and lead research in various aspects related to Intelligent Systems.

CO5 CO6. Cover a broad spectrum of AI concepts and methods and apply some of them in programming assignments.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				a	b	c	d	e	f	g	h	i	j	k	l
1.	CO1	**L1, L3**	**09**	3					1			1		2	
2.	CO2	**L1, L2**	**09**	3		2			1			1			
3.	CO3	**L1, L3, L4**	**12**			3			2						
4.	CO4	**L3,L4**	**12**			2			1			2		3	
5.	CO5	**L2,L3,L4**	**10**			3			1			2		2	

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	**PSO1**	**PSO2**	**PSO3**

CO1	3	1	
CO2	3	1	
CO3	3		
CO4	3		
CO5	3	1	
Average CO	**3**	**1**	

Text Books.

1 *D.W.Patterson, "Introduction to Artificial Intelligence and Expert Systems", First edition PHI Publisher, 2009*

2 *J.Vlach and Singhal, "Computer Methods for Circuit Analysis and Design", First edition, CBS Publishers 1986*

Reference Text Books.

1 *Elaine Rich, Kevin Knight, "Artificial Intelligence", second edition, TMH publisher, 2008*

2 *Charniak E. and McdermottD, "Introduction to AI", second edition, Pearson Education, 2000*

3 *Nils J.Nilson, "Problem Solving Methods in AI", First edition McGraw-Hill, 1971*

4 *Nils J.Nilson, "Principles of AI,", First edition, Berlin Springer, 1980*

Web Links.

1 www.aitrends.com

2 news.mit.edu/topic/artificia

3 reddit.com/r/artificial

Subject Title : COMPUTER CONTROL OF ELECTRIC DRIVES

Sub.Code:EE835	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Asmt+SEE= 45+5 + 50 = 100 Marks	Total No.of Contact Hours:52

Course Learning Objectives:

1	Introduction to modern digital control of drives, different types of sensors and to study the concept of ac machine drives in detail.
2	To learn phase controlled converters, principles of slip power recovery schemes and to know about principle of Vector Control of AC Drives.
3	To learn about Applications of expert system to Drives.
4	To have knowledge about principle of Vector Control of AC Drives
5	To learn design methodology of drives and fuzzy logic control feedback system.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Review of Micro Controllers in Industrial Drives System**: Typical Micro controller's 8-bit 16-bit (only block diagram) Digital Data Acquisition system, voltage sensors, current sensors, frequency sensors and speed sensors. TEXT 1 and TEXT 2. Reference Book	10	L1,L2,L3.
2	**AC Machine Drives:** general classification and National Electrical Manufacturer Association (NEMA) classification, Speed control of Induction motors with variable voltage constant frequency, constant voltage variable frequency, (v/f) constant operation, drive-operating regions. Variable stator current operation. Effect of Harmonics. TEXT 1 and TEXT 2. Reference Book	11	L1,L2,L3.
3	**a) Phase Controlled Converters:** Converter controls, Linear firing angle control, cosine wave crossing control, and phase locked	11	L1,L2,L3.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	Oscillator principle, Electromagnetic Interference (EMI) and line power quality problems, cyclo converters, voltage fed converters, Rectifiers, and Current fed converters. b) **Principles of Slip Power Recovery Schemes:** Static Kramer's drive system, block schematic diagram, phasor diagram and limitations, Static Scherbins scheme system using D.C link converters with cyclo converter modes of operation, modified Scherbins Drive for variable source, constant frequency (VSCF) generation. TEXT 1 and TEXT 2. Reference Book		
4	**Principle of Vector Control of AC Drives:** Phasor diagram, digital Implementation block diagram, Flux vector estimation, indirect vector control block diagram with open loop flux control, synchronous motor control with compensation. TEXT 1 and TEXT 2. Reference Book	10	L1,L2,L3.
5	**Expert System Application to drives (Only Block Diagram):** Expert system shell, Design methodology, ES based P-I tuning of vector controlled drives system, Fuzzy logic control for speed controller in vector control drives, structure of fuzzy control in feedback system. TEXT 1 and TEXT 2. Reference Book	10	L1,L2,L3.

Note 1: Unit 1 to 5 will have internal choice

Note2:

c) Two assignments are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2 from Units 3, 4 and 5

d) Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project/Seminar.

Note:3 Out of 5 Units, Unit 2 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes:

CO1	Learn about Digital Data Acquisition System and all types of sensors in detail.
CO2	Understand the concept of AC Machine Drives operation and characteristics.
CO3	Know about different types of phase controlled converters.
CO4	Learn about digital implementation and principle of vector control of AC drives.
CO5	Learn design methodology of drives and fuzzy logic control feedback system.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12

1.	CO1	**2**	**10**	**3**	**3**		**2**						**1**		**2**
2.	CO2	**2**	**11**	**3**	**3**			**2**							**2**
3.	CO3	**2**	**10**	**3**	**3**			**2**					**2**		**2**
4.	CO4	**4**	**10**	**3**	**3**		**2**		**2**		**2**				**2**
5.	CO5	**5**	**11**	**3**	**3**			**2**			**2**				**2**
Average CO				**3**	**3**			**2**	**2**		**2**		**2**		**2**

Course Outcome mapping to Programme Specific Outcome

Course Outcome	PSO1	PSO2	PSO3
CO1	3		
CO2		2	1
CO3	3		
CO4		1	1
CO5	3	2	
Average CO	3	2	1

Text Books.

1 *Bimal K.Bose, "Power Electronics & Motor Drives", First Edition, Elsevier, 2006*

2 *Bimal K. Bose, ". Modern Power Electronics & Drives", First edition, Pearson Education, 2003.*

Reference Text Books.

1 *Badri Ram, "Advanced Microprocessor and Interfacing", 1st Edition, TMH, 2001*

Web Links.

1 www.nptel.com

Subject Title : MICRO AND SMART SYSTEM TECHNOLOGY

Sub.Code: EE836	No. of Credits:04=04:0:0 (L - T – P)	No. of Lecture Hours/Week : 04
Exam Duration:03 Hrs	CIE+Assmt +SEE=45+5+50=100	Total No.of Contact Hours:52

Course Learning Objectives:

1 Gain knowledge of smart materials, sensors & actuators, microsystems.

2 Understand the operation of smart devices & systems, electronic circuits & control for mems, methodology of micro-manufacturing

3 The objective of this multidisciplinary course is to provide necessary fundamental knowledge and experience in the design, manufacture, and packaging of microsystems.

4 To identify the different techniques of electronic circuit control

5 Understand the integration of microelectronic systems.

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
1	**Introduction to micro and smart systems:** a) What are smart-material systems? Evolution of smart materials, structures and systems. Components of a smart system. Application areas. Commercial products. b) What are Microsystems? Feynman's vision. Micro machined transducers. Evolution of micro manufacturing. Multi-disciplinary aspects. Applications areas. Commercial products. **Micro and smart devices and systems:** principles and materials: a) Definitions and salient features of sensors, actuators, and systems. b) Sensors: silicon capacitive accelerometer, Piezo-resistive pressure sensor, blood analyser, conduct metric gas sensor, fibre-optic gyroscope and surface-acoustic-wave based wireless strain sensor. c) Actuators: silicon micro-mirror arrays, Piezo-electric based inkjet print-head, electrostatic comb-drive and micromotor, magnetic micro relay, shape-memory-alloy based actuator, electro-thermal actuator d) Systems: micro gas turbine, portable clinical analyser, active noise control in a helicopter cabin TEXT 1 Reference 1	12	L1, L2, L3
2	**Micro manufacturing and material processing:** a) Silicon wafer processing, lithography, thin-film deposition, etching (wet and dry), wafer bonding, and metallization. b) Silicon micromachining: surface, bulk, molding, bonding based process flows. c) Thick-film processing: d) Smart material processing: e) Processing of other materials: ceramics, polymers and metals f) Emerging trends	12	L1 -L4

Unit No	Syllabus Contents	No.of Hours	Blooms Taxnomy level.
	Modeling: a) Scaling issues. b) Elastic deformation and stress analysis of beams and plates. Residual stresses and stress gradients. Thermal loading. Heat transfer issues. Basic fluids issues. c) Electrostatics. Coupled electro mechanics. Electromagnetic actuation. Capillary electro-phoresis. Piezoresistive modeling. Piezoelectric modeling. Magnetostrictive actuators. TEXT 1Reference 1		
3	**Computer-aided simulation and design:** Background to the finite element method. Coupled-domain simulations using Matlab. Commercial software. TEXT 1Reference 1	09	L1-L4
4	**Electronics, circuits and control:** Carrier concentrations, semiconductor diodes, transistors, MOSFET amplifiers, operational amplifiers. Basic Op-Amp circuits. Charge-measuring circuits. Examples from microsystems. Transfer function, state-space modeling, stability, PID controllers, and model order reduction. Examples from smart systems and micro machined accelerometer or a thermal cycler. TEXT 1Reference 1	09	L1-L5
5	**Integration AND packaging of microelectro mechanical systems:** Integration of microelectronics and micro devices at wafer and chip levels. Microelectronic packaging: wire and ball bonding, flip-chip. Low-temperature-cofired-ceramic (LTCC) multi-chip-module technology. Microsystem packaging examples. Case studies: BEL pressure sensor, thermal cycler for DNA amplification, and active vibration control of a beam. TEXT 1Reference 1	10	

Note 1: Unit 1 to 5 will have internal choice

Note2: Two assignments are evaluated for 5 marks: Assignment -1 from Units 1,2 and 3. Assignment -2 from Units 3, 4 and 5

Note:3 Out of 5 Units, Unit 1 is a Webinar unit conducted through Google Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty.

Course Outcomes

CO1	Describe fundamentals and design principles.
CO2	Describe modeling techniques and fabrication methods.
CO3	Perform computer-aided simulation and design.
CO4	Describe applications of smart systems
CO5	Integrate microelectronics and micro-devices at wafer and chip level.

Course Outcomes Mapping with Programme Outcomes.

Sl.No	Course Outcome	Level of Blooms Taxonomy	No. of hours of teaching	Programme Outcome											
				1	2	3	4	5	6	7	8	9	10	11	12
1.	**CO1**	1	13	3	2								1		1
2.	**CO2**	2	7	3	3								1		1
3.	**CO3**	4	8	3	3				1	1			1		1
4.	**CO4**	5	7	3	3				1	1			1		1
5.	**CO5**	5	7	3	3				1	1			1		1
Average CO				3	3				1	1			1		1

Course Outcomes Mapping with Programme Specific Outcomes.

Course Outcome	PSO1	PSO2	PSO3
CO1	3		
CO2	3	2	
CO3	3		
CO4	3		1
CO5	3	2	
Average CO	**3**	**2**	**1**

Text Books.

1 Tai-Ran Hsu, “MEMS & Microsystems: Design and Manufacture”, First edition, TMH education private limited, new Delhi, ,

2

Reference Text Books.

1 1.A CD-supplement with Matlab codes, photographs and movie clips of processing machinery and working devices., “Animations of working principles, process flows and processing techniques”

2. Laboratory hardware kits for, “(i) BEL pressure sensor, (ii) thermal-cycler and (iii) active control of a cantilever beam.”

3. Microsystems Design, S. D. Senturia,, “2001, Kluwer Academic Publishers, Boston, USA.ISBN 0-7923-7246-8.”

4. Analysis and Design Principles of MEMS Devices, “Minhang Bao, Elsevier, Amsterdam, The Netherlands, ISBN 0-444-51616-6.”

5. Design and Development Methodologies, Smart Material Systems and MEMS, “V. Varadan, K. J. Vinoy, S. Gopala Krishnan, Wiley. MEMS- Nitaigour Premchand Mahalik, TMH 2007”

Panchajanya Vidya Peetha Welfare Trust (Regd)

Dr. Ambedkar Institute of Technology

Aided by Govt. of Karnataka, An Autonomous Institution, Affiliated to Visvesvaraya Technological University, Belagavi,
Approved by All India Council for Technical Education (AICTE), New Delhi, Accredited by NBA and NAAC with 'A' Grade
BDA Outer Ring Road, Mallathahalli, Bengaluru - 560 056

Ref. No. ....

Date : 05.01.2023

2019-20

Subjects focusing on Employability/Entrepreneurship/Skill development for the year

S.No	Subject Code	Subject
1.	18EE31	Analog Electronic Circuits
2.	18EE32	Logic Design
3.	18EE33	Network Analysis
4.	18EE34	Transformer and Induction Machines
5.	18EEL35	Electronic Circuits Lab
6.	18EEL36	Logic Design Lab
7.	18EE41	Electrical & Electronic Measurements and Instruments
8.	18EE42	Control Systems
9.	18EE43	DC Machines and Synchronous Machines
10.	18EE 44	Power Electronics
11.	18EE 45	Linear Integrated Circuits & Applications
12.	18EE L46	Transformer and Induction Machines Lab
13.	18EE L47	Power Electronics Lab
14.	EE51	Signal & Systems
15.	EE52	Power Electronics-II
16.	EE53	DC Machines & Synchronous Machines
17.	EEL56	Control Systems Lab.
18.	EEL57	Power Electronics Lab
19.	EEL58	Simulation Lab
20.	EE541	Advanced Instrumentation System
21.	EE542	Embedded Systems
22.	EE543	Modern Control Theory
23.	EE551	VLSI Circuits & Design
24.	EE552	Operating System
25.	EE553	Linear IC's and Applications
26.	EE61	Power Systems Analysis
27.	EE62	Electrical Machine Design
28.	EE63	Digital Signal Processing
29.	EEL66	DC Machines & Synchronous Machines Lab.
30.	EEL67	Digital Signal Processing lab
31.	EE641	Electrical Power Utilization

32.	EE642	Electrical Design, Estimating and Costing
33.	EE643	Programmable Logic Controllers
34.	EE651	Power System Planning
35.	EE652	Special Machines
36.	EE653	Reactive Power Management
37.	EE71	Computer Techniques in Power System Analysis
38.	EE72	High Voltage Engineering
39.	EEL74	Relay & HV Lab
40.	EEL75	Power Systems Simulation Laboratory
41.	EEL76	Electrical Drawing
42.	EE731	Flexible AC Transmission Systems(FACTS)
43.	EE732	Energy Auditing & Demand Side Management
44.	EE733	Power Systems Dynamics & Stability
45.	EE734	Electrical Power Quality
46.	EE735	Fuzzy Logic
47.	EE736	Artificial Neural Network
48.	EE737	Alternate Energy Sources
49.	EE738	Advanced Power Electronics*
50.	EE81	Modern Power System Protection
51.	EE82	Power System Operation & Control
52.	EE831	Testing & Commissioning of Electrical Equipment
53.	EE832	HVDC Transmission
54.	EE833	Insulation Engineering
55.	EE834	Artificial Intelligence Applications to Power Systems
56.	EE835	Computer Control of Electrical Drives
57.	EE836	Micro & Smart System Technology
58.	EE837	Advanced Control System
59.	EE838	Electromagnetic Compatibility

BOS Chairman

Principal

Course Title : **ANALOG ELECTRONIC CIRCUITS**		
Course Code : **18EE31**	No. of Credits:**4,** L:T:P **- 4:0:0**	No. of hours/week: **4**
Exam Duration: **3 hrs.**	**Marks:** CIE + Assignment + GA + SEE **= 40 + 5 + 5+50 = 100**	Total No. of Contact Hours: **52**

Course Objective:

1. To study the basic concepts of diode circuits such as clippers, clampers and rectifiers
2. To analyze and design of different transistor circuit biasing along with bias stabilization.
3. To study the modeling of transistor& to analyze general, feedback and power amplifiers.
4. The basics concept of oscillators and FET amplifiers along with characteristics

Unit No.	Syllabus Content	No. of Hours
1	**Diode Circuits:** Diode resistance, diode equivalent circuits, transition and diffusion capacitances, clippers and clampers, rectifiers. **(BT Levels: L1 & L2)**	10
2	**Transistor Biasing**: Operating point, analysis and design of fixed bias circuits, emitter stabilized biased circuits, voltage divider bias, and collector voltage feedback bias. Transistor switching circuits. Bias stabilization: stability factor of different biasing circuits. **(BT Levels: L2 & L3)**	10
3	**Transistor Modeling and Frequency Response:** Transistor as two port network, low frequency hybrid model., relation between h– parameter model of CE, CC and CB modes, Millers theorem and its dual. General frequency considerations, low frequency response, miller effect capacitance, high frequency response. **(BT Levels: L3 & L4)**	10
4	**a) Multistage Amplifiers:** Cascade and cascade connections, Darlington circuits, analysis and design. **b) Feedback Amplifiers:** Feedback concept, different type of feedback circuits- block diagram approach, analysis of feedback circuits. **c) Power Amplifiers**: Amplifier types, analysis and design of Class A & Class B amplifiers, Harmonic distortion **(BT Levels: L3 & L4)**	11
5	**a) Oscillators:** Principle of operation, analysis of phase shift oscillator, Wien bridge oscillator, RF and crystal oscillator.(BJT versions) **b) Field Effect Transistors:** Construction, working and characteristics of JFET and MOSFET. Biasing of JFET .Analysis and design of JFET(only common source configuration with fixed bias) **(BT Levels: L4 & L5)**	11

Course Outcome: At the end of the course students will be able to -

CO1. Recall the basic diode circuits and describe various wave shaping circuits.
CO2. Explain the working of transistor biasing circuits and locate quiescent point.
CO3. Analyze the models of transistor & FET amplifier circuits.
CO4. Design and develop various transistor amplifier circuits.
CO5. Construct and solve the transistor oscillator circuits.

TEXT BOOKS:

1. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education. 11^{TH} Edition, 2015.

REFERENCE BOOK/WEBSITE LINKS:

1. Jacob Millman & Christos C. Halkias, Integrated Electronics, Tata McGraw Hill, 4^{th}Edition, 2015.
2. David A. Bell, Electronic Devices and Circuits, Oxford University Press, 5^{th} Edition, 2008

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-I**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*				*	*		*	*
CO2	*	*	*	*				*	*		*	*
CO3	*	*	*	*				*	*		*	*
CO4	*	*	*	*				*	*		*	*
CO5	*	*	*	*				*	*		*	*

Course Title : **LOGIC DESIGN**		
Course Code : **18EE32**	No. of Credits:**3;** L:T:P **3:0:0**	No. of hours/week:**3**
Exam Duration: **3 hrs.**	Marks: CIE + Assignment + SEE **= 40 + 5 + 5 + 50 = 100**	Total No. of Contact Hours: **39**

Course Objective:
1. To provide a comprehensive introduction to fundamentals of digital logic design. Karnaugh Map Techniques, Quine Mckluskey and MEV Techniques.
2. To design and analyze combinational and sequential circuits.

Unit No.	Syllabus Content	No. of Hours
1	**a) Principles of Combinational Logic-I (Karnaugh maps)** - 3, 4 and 5 variables, Incompletely specified functions (Don't Care terms), Simplifying Max term equations. **b) Principles of Combinational Logic-II:** Limitations of K-Maps, Quine-McCluskey Tabulation Algorithm, Quine-McCluskey using don't care terms, Map entered variables (one and two map variables). **(BT Levels: L1 & L2)**	08
2	**Analysis and design of combinational logic – I:** General approach for design of combinational logic circuits, decoders-BCD decoders (Logic design using decoders), encoders, priority encoder. **(BT Levels: L2 & L3)**	07
3	**Analysis and design of combinational logic – II:** Digital multiplexers-using multiplexers as Boolean function generators. Binary adders and subtractors, binary comparators. (1 bit, 2 bits and 4 bits) **(BT Levels: L2 & L3)**	08
4	**Sequential Circuits – I:** Basic bistable element, Latches - SR latch, master-slave flip-flops (pulse-triggered flip-flops): The master-slave SR flip-flops, master-slave JK flip-flops, edge triggered flip-flops: The positive edge-triggered D flip-flops, negative-edge triggered D flip-flop **(BT Levels: L4 & L5)**	08
5	**Sequential Circuits –II:** Characteristic equations, registers, counters - binary ripple counters, synchronous binary counters, counters based on shift registers (ring and Johnson), design of a synchronous counters, design of a synchronous mod-6 counter using clocked JK, D, T & SR flip-flops. Sequential Circuit Design - Mealy and Moore models. **(BT Levels: L4 & L5)**	08

Course Outcome: At the end of the course students will be able
CO1: To exemplify the concept of combinational systems using standard gates and minimization methods (Karnaugh Maps up to 5 variables)
CO2: To identify the limitations of K- map and use computerized simplification Techniques (Quine Mckluskey tabulation and MEV methods).
CO3: To analyze and design combinational systems composed of standard combinational modules, such as multiplexers, decoders, encoders, adders, subtractors and binary comparators.
CO4: To demonstrate knowledge of simple synchronous sequential systems (flip-flops and latches).
CO5: To analyze and design sequential systems composed of standard sequential modules, such as counters, registers, Mealy and Moore Models.

TEXT BOOKS:

1. Digital Logic Applications and Design, John M Yarbrough, Thomson Learning, 2001.
2. Digital Principles and Design, Donald D Givone, Tata McGraw Hill Edition, 2002.

REFERENCE BOOK/WEBSITE LINKS:

1. Fundamentals of logic design, Charles H Roth, Jr; Thomson Learning, 2004.
2. Logic and computer design Fundamentals, Mono and Kim, Pearson, Second edition, 2001.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*							*		*
CO2	*	*	*							*		*
CO3	*	*	*							*		*
CO4	*	*	*							*		*
CO5	*	*	*							*		*

Course Title : **NETWORK ANALYSIS**		
Course Code : **18 EE33**	No. of Credits: **4;** L:T:P **- 3:1:0**	No. of hours/week:**3+2**
Exam Duration: **3 hrs.**	CIE + Assignment + SEE = **40 + 5 + 5 + 50 = 100** Marks	Total No. of Contact Hours: **39+26**

Course Objective:
1. To provide fundamental knowledge of AC and DC networks. And apply network theorems for various electrical circuits.
2. To determine the solution of electrical network using Laplace transformations, Steady state behavior of circuit elements and frequency response in resonant circuits

Unit No.	Syllabus Content	No. of Hours
1	**Basic Concepts**: Practical sources, source transformations, network reduction using star – delta transformation, loop and node analysis with linearly dependent and independent sources for DC and AC networks. Concepts of super node and super mesh. **(BT Levels: L1 & L2)**	7+5
2	**Network Theorems:** Superposition theorem**,** Reciprocity theorem, Thevinin's theorem, Norton's theorem and Maximum Power transfer theorem. **(BT Levels: L2 & L3)**	8+5
3	**Laplace Transformation & Applications**: Solution of networks, step, ramp and impulse responses, waveform Synthesis. **(BT Levels: L3 & L4)**	7+**5**
4	**a) Resonant Circuits:** Series and parallel resonance, frequency-response of series and parallel circuits, Q factor, bandwidth. **b) Transient behavior and initial conditions**: Behavior of circuit elements under switching condition and their representation, Evaluation of initial and final conditions in RL, RC and RLC circuits for DC excitations. **(BT Levels: L3 & L4)**	8+5
5	**a) Network Topology:** Graph of a network, Concept of tree and co-tree, incidence matrix, tie-set and cut-set schedules, Formulation of equilibrium equations in matrix form, solution of resistive networks and principle of duality**.** **b) Two port network parameters:** Definition and Calculation of z, y, h and ABCD transmission parameters. Modeling with these parameters. **(BT Levels: L4 & L5)**	9+6

Course Outcome: At the end of the course students will be able to -
CO1: Understand the concepts of nodal and mesh methods.
CO2: Express complex circuits in their simple form using different theorems.
CO3: Analyze the circuit using time and frequency domain.
CO4: Analyze and design resonant circuits.
CO5: Model the various electrical networks using two port circuits.

TEXT BOOKS:

1. **Engineering Circuit Analysis,** Hayt, Kemmerly and Durbin,TMH , 7th Edition, 2010
2. **Networks and systems,** Roy Choudhury, New Age International Publications. 2nd edition, 2006 re-print,

REFERENCE BOOK/WEBSITE LINKS:

1. Introductory Circuit Analysis, Robert L and Boylestad, Pearson, print, 2011
2. Network Analysis and Synthesis, A K Chakraborty, S P Ghosh, TMH, 1ST Edition, 2009.
3. **Electric Circuits,** M Nahvi and J A Edminister, Schaum's Outlines TMH, 5th Edition, 2009.
4. **Network Analysis,** M. E. Van Valkenburg, PHI, 3rd Edition, Reprint 2009.
5. **Analysis of Linear Systems**, David K. Cheng, Narosa Publishing House, 11th reprint, 2002.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*								*
CO2	*	*	*	*								*
CO3	*	*	*	*						*		*
CO4	*	*	*	*						*		*
CO5	*	*	*	*								*

Course Title : **TRANSFORMERS AND INDUCTION MACHIES**		
Course Code : **18 EE33**	No. of Credits: **4;** L:T:P- **4:0:0**	No. of hours/week: **4**
Exam Duration: **3 hrs.**	**Marks** : CIE + Assignment + GA + SEE = **40 + 5 + 5 + 50 = 100**	Total No. of Contact Hours: **52**

Course Objective:

1. To understand the working of transformers and induction machines.
2. To Analyze and evaluate the performance of transformers and induction machines.
3. To analyze operation of transformers in different configurations and operate in parallel.
4. To understand starters and analyze speed control of induction motor and induction generator.
5. To analyze induction motor with high torque rotors construction.

Unit No.	Syllabus Content	No. of Hours
1	**Transformers:** EMF equation, losses and commercial efficiency, condition for maximum efficiency. Concept of ideal transformer, operation of practical power transformer under no load and on load -with phasor diagrams. Equivalent circuit, Open circuit and Short circuit tests, calculation of parameters of equivalent circuit and predetermination of efficiency-commercial and all-day **(BT Levels: L1& L2)**	10
2	**a)Transformer continuation:** Voltage regulation and its significance. Testing of transformers - polarity test, Sumpner's test. **b)Three-phase Transformers:** Introduction, choice between single unit three-phase transformer and bank of single-phase transformers. Transformer connection for three phase operation – star/star, delta/delta, star/delta, delta /star and V/V**.** Scott connection for three-phase to two-phase conversion. Labeling of three-phase transformer terminals. Current inrush in transformers. **(BT Levels: L2 & L3)**	10
3	**a) Parallel operation (Single-phase & Three-phase)**: Need, conditions to be satisfied for parallel operation. Load sharing in case of similar and dissimilar transformers. **b) Instrument Transformers:** Current transformer and Potential transformer. Welding Transformers **c) Three phase Induction Machines:** Concept of Induction motor as a rotating tr ansformer, Characteristic Induction Motor continuation: Slip, torque, torque-slip characteristic. Maximum torque. **(BT Levels: L3 & L4)**	10
4	**a) Three phase Induction Machines (Contd..):** Phasor diagram of induction motor on no-load and on load. Equivalent circuit, losses, efficiency. No-load and blocked rotor tests. Circle diagram and performance evaluation of the motor. Cogging and crawling. **b) Starters & Speed Control of Three-phase Induction Motors:** Need for starter. Direct on line (DOL) starters, Star-Delta and autotransformer starting. Rotor resistance starting. Soft (electronic) starters. Speed control - voltage, frequency, and rotor resistance. **(BT Levels: L4 & L5)**	11
5	**a) High torque rotors -** Double Cage and deep bar rotor, Equivalent circuit, and performance evaluation of double cage induction motor. Induction generator – externally excited and self-excited. Importance and applications of induction generators. **b) Single-phase Induction Motor:** Double revolving field theory, principle of operation. Types of single-phase induction motors: split-phase, capacitor start, shaded pole motors. Applications. **(BT Levels: L4 & L5)**	11

Course Outcome: At the end of the course students will be able to -
CO1: Explain operation of transformers and induction machines (1-phase and 3-phase).
CO2: Evaluate the performance of transformers and induction machines.
CO3: Understand the different connections for the three phase operations, advantages and applications.
CO4: Analyze induction motors with different rotors and as induction generator.
CO5: Understand the different starters and speed control techniques of three-phase induction motors.

TEXT BOOKS:

1. **Electric Machines,** I. J. Nagrath and D. P. Kothari, T.M.H, 4th Edition, 2010.
2. **Electrical technology-AC & DC Machines Vol-2, B L Theraja, S Chand Publishers.**

REFERENCE BOOK/WEBSITE LINKS:

1. **Performance and Design of A.C. Machines,** M. G. Say, C.B.S Publishers, 3rd Edition, 2002.
2. **Theory of Alternating Current Machines,** Alexander Langsdorf, T.M.H, 2nd edition, 2001.
3. **Electrical Machines and Transformers**, Kosow, Pearson, 2nd edition, 2007.
4. **Electric Machines,** Mulukuntla S.Sarma, MukeshK.Pathak, CengageLearing, Firstedition, 2009.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*		*								*
CO2	*	*		*								*
CO3	*	*	*		*						*	*
CO4	*	*		*	*						*	*
CO5	*	*		*	*						*	*

Course Title : **ELECTRONIC CIRCUITS LAB**		
Course Code : **18 EEL36**	No. of Credits : **1;** L:T:P **- 0:0:1**	No. of hours/week: **2**
Exam Duration**: 3 hrs.**	Marks CIE + SEE =**50 + 50 = 100**	

Course Objective:

1. To construct various diode circuits to shape the waveforms to given specifications.
2. Design resonant circuits to resonate at required frequencies.
3. Design and test various amplifier circuits.
4. Design and verify circuits to oscillate at specified frequency.

Unit No.	Syllabus Content
	Introduction: Use of bread board, CRO, power supplies, signal generators, DRBs, DIBs, DCBs; color codes, resistors, inductors, capacitors, rheostats, multimeters; transistors, diodes; device data sheets.
1	**Clipping Circuits**: Design and testing of diode shunt, series and peak detection clippers
2	**Clamping Circuits**: Design and testing of diode clamping circuits.
3	**Rectifier Circuits**: Testing of half wave, full wave and bridge diode rectifiers with and without capacitor filter, determination of ripple factor, regulation and efficiency.
4	**Resonant Circuits:** Characteristics of series and parallel resonant circuits.
5	**Transistor Static Characteristics:** CE, CB and CC modes and determination of h parameters.
6	**RC Coupled Amplifier:** Design of single stage BJT amplifier and determination of the gain-frequency response, input and output impedances.
7	**Darlington Emitter Follower:** Design of BJT Darlington emitter follower circuit and determination of the gain, input and output impedances.
8	**RC Phase Shift Oscillator**: Design and testing for the performance of BJT-RC Phase shift oscillator for a frequency, $f_0 \leq 10$ kHz
9	**Tuned Oscillators:** Design and testing of the performance of BJT-RC Hartley and Colpitt's oscillator for frequency, $f_0 \geq 100$ kHz
10	**Crystal Oscillator:** Design and testing of BJT -crystal oscillator for $f_0 > 1$ MHz
11	**Cascade Amplifier:** Design of RC coupled two stage amplifier and determination of the gain-frequency response, input and output impedances.*
12	**Push Pull Amplifier:** Design and testing of class B push pull power amplifier.*
	*** - Experiments beyond the syllabus**

Course Outcome: At the end of the course students will be able to -

CO1. Explain the working of diode wave shaping circuits and to draw transfer characteristics.

CO2. Evaluate the characteristics of BJTs.

CO3. Test the resonant circuits resonating at required frequency.

CO4. Design of amplifier circuit, draw frequency response and determine input and output impedances

CO5. Construct and test transistor circuits to oscillate at desired frequencies.

REFERENCES:

1. Robert L. Boylestad and Louis NashelskyElectronic Devices and Circuit Theory, PHI/Pearson Education. 9^{TH} Edition.

2. Laboratory Manual

COs	**Mapping with Pos**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*	*					*	*	*
CO2	*	*		*	*					*	*	*
CO3	*	*		*	*					*	*	*
CO4	*	*		*	*					*	*	*
CO5	*	*		*	*					*	*	*

Course Title : **LOGIC DESIGN LAB**		
Course Code : **18EEL37**	No. of Credits:**1;** L:T:P - **0:0:1**	No. of hours/week:**2**
Exam Duration: **2 hrs.**	Marks : CIE + SEE =**50+ 50 = 100**	

Course Objective:

1. To use the theoretical Knowledge and demonstrate the use of Boolean algebra / Postulates, K map techniques to design logic circuits using logic gates & solve Boolean Expressions.
2. To design and Analyze Combinational and sequential circuits such as Adders, Subtractors, Decoders, Encoders, Mux/Demux, Registers and counters.

Unit No.	Syllabus Content
	Introduction: Use of IC Trainer Kits, Testing & Identification of ICs, IC Data sheets.
1.	Realization of half / full Adder and half/full Subtractor using Logic gates.
2.	(i) Realization of parallel adder/Subtractors using 7483 chip (ii) BCD to Excess-3 code conversion and vice versa.
3.	Realization of Binary to gray code converter and vice versa.
4.	555 Timer
5.	Realization of One / Two bit comparator using logic gates
6.	MUX / DEMUX use of 74153, 74139 for arithmetic circuits and code conversion.
7.	4 bit magnitude comparator using IC7485.
8.	Use of (a) decoder chip to drive LED / LCD display and (b) Priority Encoder.
9.	Truth table verification of flip flops: (i) JK Master slave (ii) T type and (iii) D type.
10.	Shift left, Shift right, SIPO, SISO, PISO, PIPO operations using IC: 7495S.
	Experiments beyond the syllabus
1.	Realization of 3 bit counters as a sequential circuit & Mod-N counter design (Using IC's: 7476, 7490, 74193).
2.	Design and testing of Ring Counter / Johnson Counter using IC 7495.

Course Outcome: At the end of the course students will be able to -

CO1: Apply the concept of various ICs, Logic gates and other components used in Digital logic circuit design.

CO2: Solve K-Maps and realize Boolean expressions.

CO3: Design and implement various code converters.

CO4: Design and implement combinational circuits for various digital applications.

CO5: Design and implement sequential circuits

REFERENCES:

1.Digital Lab Primer, K.A. Krishnamurthy, Pearson Education Asia publications, 2003

2.Laboratory Manual

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*		*				*	*		*
CO2	*	*	*		*				*	*		*
CO3	*	*	*		*				*	*		*
CO4	*	*	*		*				*	*		*
CO5	*	*	*		*				*	*		*

Course Title: **ELECTRICAL AND ELECTRONIC MEASUREMENTS AND INSTRUMENTS**		
Course Code : **18EE41**	No. of Credits:**3**; L:T:P **- 3:0:0**	No. of hours/week: **3**
Exam Duration: **3 hrs.**	Marks: CIE + Assignment + GA + SEE **= 40 + 5 + 5 + 50 = 100**	Total No. of Contact Hours: **39**

Course Objectives:

1. Understand the errors encountered in measuring instruments
2. Derive the balance conditions in AC and DC bridges for the measurement L, C, R and dissipation factor etc.
3. To analyze the working of analog and digital measuring instruments, and determine the necessary conditions for working of instrument transformers.
4. To analyze the working principles of signal generators used in the laboratories.
5. To distinguish and describe various transducers and display devices used in instrumentation.

Unit No.	**Syllabus Content**	**No. of Hours**
1	**Measurement of Power, Energy, Power factor and Frequency:** Dynamometer wattmeter construction and working principle UPF and LPF wattmeters. Measurements of real and reactive power in 3 phase circuits. Induction type energy meter construction and operation. Construction and operation of single-phase and three phase dynamometer type power factor meter. Weston frequency meter and phase sequence indicator.	8
2	**a) Measurement Errors:** Definition of error, Gross errors and systematic errors, Absolute and relative errors, Accuracy, Precision, Resolution and Significant figures. **b) Digital Instruments:** Introduction, digital voltmeters (DVM) of ramp type, successive approximation principles, resolution and sensitivity, general specifications, Digital Multimeters. ADC and DAC. Digital frequency meters.	8
3	**Bridges:** Wheatstone's bridge, Kelvin Bridge; AC bridges - Capacitance Comparison Bridge, Maxwell's bridge, Wein's bridge, Schering bridge , D'sautys bridge, Wagner's earth connection, examples.	7
4	**a) Measuring Instruments (AC and DC):** Introduction, ammeter, voltmeter, wattmeter (dynamometers type), energy's meter (induction type).Multi-range voltmeter, extending voltmeter range. AC voltmeter using Rectifiers – Half wave and full wave, Peak responding and True RMS voltmeters, ammeters, multimeters. b) **Instrument Transformers:** Construction and theory of instrument transformers, ratio and phase angle errors of C.T. and P.T. including derivation and Numerical problems.	8
5	**a)Signal Generators and Analyzers:** Introduction, Fixed and variable AF oscillator, standard signal generator, laboratory type signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator, Sweep frequency generator. **b) Display Devices**: Digital display system, classification of display, Display devices, LEDs, LCD, Analog and Digital storage oscilloscope.	8

Course Outcome: At the end of the course students will be able to -

CO1: Define the different measuring network parameters and understand the measuring techniques in analog and digital systems.

CO2: Analyze the different methods of implementation in the working of measuring instruments and compare the end results.

CO3: Assess the performance of different measuring instruments.

CO4: Analysis of various generated waveforms using various instruments

CO5: Plan and design various measuring instruments for their innovation.

TEXT BOOKS:

1 Electrical and Electronic Measurements and Instruments, R K Rajput, S Chand, 3rd edition, 2013

REFERENCE BOOK/WEBSITE LINKS:

1. Modern electronic instrumentation and measuring techniques , Cooper D & A D Helfrick, 1998,PHI,. ISBN-8120307526
2. Electronic Instrumentation and Measurements , David A Bell, PHI,2nd Edition, 2006,ISBN 10: 0132499541
3. A Course in Electronics and Electrical Measurements and Instruments, J B Gupta, Katson Books, 13th edition, 2008
4. A Course in Electronics and Electrical Measurements and Instruments, A K Sawhney, Dhanpat Rai publishers,2015

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*		*	*	*		*		
CO2	*	*		*	*	*	*		*	*		*
CO3	*	*	*	*	*	*	*	*	*	*	*	*
CO4	*	*	*	*	*	*	*		*	*		*
CO5	*	*	*		*		*		*	*	*	*

DR. AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU – 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMESTER		
Course Title : CONTROL SYSTEMS		
Course Code : 18 EE42	No. of Credits:4; L:T:P - 3:0:0	No. of hours/week: 4
Exam Duration: 3hrs.	Marks: CIE + Assignment + GA + SEE = **40 + 5 + 5 + 50 = 100**	Total No. of Contact Hours: 39+26

Course Objective:

1. To make the students aware of the basics of control system, its classification, the basic theory of Transfer Function, Impulse response and mathematical modeling for the overall analysis of the control system. Obtain transfer function using Block Diagram and Signal Flow Graph.
2. To make them understand the time response of feedback control systems and steady state errors.
3. Stability analysis is thought using various methods like Routh Hurwitz criterion, Root Locus and Bode Plot.

Unit No.	Syllabus Content	No. of Hours
1	a) **Modeling of Systems:** Introduction to control system, Mathematical models of physical systems – Introduction, Differential equations of physical systems. Mechanical systems – Translational and rotational systems (Mechanical accelerometer, Levered systems excluded), Electrical Analogous systems. P, PI and PID controllers. b) **Servomotor:** transfer functions, applications. c) **Block diagrams and signal flow graphs**: Transfer functions, Block diagram algebra, Signal Flow graphs (State variable formulation excluded)	11
2	**Time Response of feedback control systems:** Standard test signals, Unit step response of first and second order systems, Time response specifications, Time response specifications of second order systems, steady state errors and error constants.	10
3	a) **Stability analysis:** Concepts of stability, Necessary conditions for stability, Routh-stability criterion, Relative stability analysis. b) **Root Locus Techniques:** Introduction, root locus concepts, Construction of root loci and stability studies.	11
4	a) **Frequency domain analysis:** Introduction, Correlation between time and frequency response, bode plots, all pass and minimum phase systems, Assessment of relative stability using Bode Plots. b) Lag and lead compensators.	10
5	**Stability in the frequency domain:** Mathematical preliminaries, Nyquist stability criterion (Inverse polar plots excluded), Assessment of relative stability using Nyquist criterion (systems with transportation lag excluded).	10

Course Outcome: At the end of the course students will be able to -
CO1: Demonstrate an understanding of the fundamentals of control systems.
CO2: Apply the concepts to develop mathematical modeling and transfer function of any system using various techniques.
CO3: Analyze the control system with respect to system stability in time and frequency domain.
CO4: Analysis of system stability using graphical methods.
CO5: Design system using compensator for better performance.

TEXT BOOKS:
1. Control Systems Engineering, J. Nagarath and M.Gopal, New Age International (P) Limited, Publishers, First edition – 2008

REFERENCE BOOK/WEBSITE LINKS:
1. Modern Control Engineering, K. Ogata, Pearson Education Asia/ PHI, 4th Edition, 2002.
2. Concepts of Control Systems, P. S. Satyanarayana; Dynaram publishers, Bangalore, 2001
3. Control Systems – Principles and Design, M. Gopal, TMH, 1999.
4. Feedback Control System Analysis And Synthesis, J. J. D'Azzo and C. H. Houpis; McGraw Hill

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*										*
CO2	*	*	*			*				*		*
CO3	*	*	*			*				*		*
CO4	*	*	*			*				*		*
CO5	*	*	*			*				*		*

DR. AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : DC MACHINES AND SYNCHRONOUS MACHINES		
Course Code : 18EE43	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	Marks: CIE + Assignment + GA + SEE = **40 + 5 + 5 + 50 = 100**	Total No. of Contact Hours: 52

Course Objective:
1. To gain knowledge on construction and working of DC machines and synchronous machines.
2. To analyze characteristics of DC machines and synchronous machines
3. To evaluate various methods of testing, losses and efficiency of DC machines.
4. To analyze various methods of determining voltage regulation of a synchronous generator.
5. To analyze the operation of a synchronous machine (both as a generator and motor).

Unit No.	Syllabus Content	No. of Hours
1	**DC Generator**: Classification of DC generator, types of armature winding, emf equation, no-load characteristic, armature reaction, load characteristics. Commutation, types of commutation, commutation difficulties, interpoles, compensating winding and equalizer rings (only qualitative treatment). Classification of DC motors, back emf and its significance, torque equation, characteristics of shunt, series & compound motors, speed control of shunt and series motors. Application of DC motors.	10
2	**a) Losses and efficiency:** Losses in dc machines, power flow diagram, efficiency, condition for maximum efficiency. **b)Testing of dc machines**: Direct & indirect methods of testing of DC machines-brake test, swine burn’s test, Hopkinson’s test, retardation test, field’s test, merits and demerits of tests.	10
3	**Synchronous machines:** Principle of operation, construction of salient & non-salient pole synchronous machines, generated emf, effect of distribution and chording of winding, harmonics-causes, reduction and elimination. Armature reaction, synchronous reactance, leakage reactance, phasor diagram of non-salient type alternator.	10
4	**Voltage Regulation**: Voltage regulation by EMF, MMF, ZPF & ASA method. Short circuit ratio and its importance. Two reaction theory-direct and quadrature axis reactance’s, phasor diagram. Slip test and regulation. Synchronizing to infinite bus bars, parallel operation of alternators. Operating characteristics, power angle characteristics excluding armature resistance, operation for fixed input and variable excitation.	12
5	**a) Synchronous motor:** Principle of operation, phasor diagrams, torque and torque angle, effect of change in load, effect of change in excitation, ‘V’ and ‘inverted V curves’. Synchronous condenser, hunting and damping. Methods of starting of synchronous motors. **b)Special DC motors**: Permanent magnet motors, brushless DC motors. Applications.	10

Course Outcome: At the end of the course students will be able to -
CO1. Explain phenomena related to DC, synchronous machines and special machines (L1).
CO2. Explain the operation, characteristics and performance of DC, synchronous machines and special machines. (L2)
CO3. Solve problems related to speed control, losses and efficiency of DC machines.(L3)
CO4. Analyze the behavior of synchronous machines in parallel and on infinite busbars.(L4)
CO5. Evaluate voltage regulation of synchronous generators by various methods. (L5)

TEXT BOOKS:

1. Electrical Machinery: DP Kothari, I.J.Nagarath, TMH, 4^{th} edition, 2010.

REFERENCE BOOK/WEBSITE LINKS:

1. Performance& Design of Alternating Current machines**:** M. G. Say, CBS publishers, 3rd Edition, 2002.
2. The Performance & Design of DC machines: A.E Clayton &N.N.Hancock CBS Publication, 3^{rd} Edition, 2004.
3. Electrical Machines: AshfaqHussain, DhanpatRai Publications.
4. Electrical Machines: P.S Bhimbra, Khanna Publishers
5. Electric Machines: Mulukuntla.S.Sarma, Mukesh.K.Pathak, Cengage Learning, First edition, 2009.
6. Electric Machines: Ahhijit Chakrabarti, SudiptaBebnath, McGraw Hill Education (India) Private Limited, New Delhi.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*		*					*
CO2	*	*	*	*	*		*					*
CO3	*	*	*	*	*		*					*
CO4	*	*	*	*	*		*					*
CO5	*	*	*	*	*		*					*

DR. AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU – 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMESTER		
Course Title : POWER ELECTRONICS		
Course Code : 18EE44	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week:4
Exam Duration: 3 hrs.	Marks: CIE + Assignment + GA + SEE = **40 + 5 + 5 + 50 = 100**	Total No. of Contact Hours: 52

Course Objective:

1. Understand and acquire knowledge about various power semiconductor devices, characteristics and their applications.
2. Introduce different converters used in power electronics systems
3. Analyze the performance of different power converter circuits for electric drives.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction to Power Semiconductor Devices:** Power semiconductor devices, applications. Thyristor types, SCR structure – static characteristics, switching characteristics of SCR, MOSFET and IGBT, ratings, two transistor model, di/dt and dv/dt protection. Firing circuits using UJT and digital ICs. Isolation of control & power circuit.	10
2	**Controlled Rectifiers:** Principle of phase controlled converter operation. Single-phase and three-phase converters – half, semi and full bridge converters with R & RL load.	10
3	**DC Choppers:** Introduction to commutation, Chopper classification, Performance parameters, control strategies, Principle of step-down and step-up chopper with R & R-L load. DC motor (Separately, Shunt & Series) Speed control, open loop and closed loop transfer function for separately excited motor -four quadrant operation of DC drive.	10
4	**a)AC Voltage Controllers:** Principle of ON-OFF and phase control with R and RL load. Single-phase bidirectional controllers with resistive and inductive loads. **b) Inverters:** Inverter classification**,** Principle of operation of basic half bridge inverter and full bridge inverter, Performance parameters. Three-phase bridge inverter-120^0 and 180^0mode of operation.	12
5	**Control of AC Drives:** Basic Induction Motor Equations, speed control of squirrel cage induction motor by voltage source inverter- stator voltage control, variable frequency control. Rotor resistance control and Slip power recovery scheme.	10

Course Outcome: At the end of the course students will be able to -

CO1: Identify and selection of power electronic devices and to study control circuit for SCR/Thyristor.
CO2: To understand and analyze different AC-DC converters for power conversion system applications.
CO3: To understand and analyze different AC-AC and AC-DC-AC converters for power conversion system applications.
CO4: To Understand the control of DC drives.
CO5: To understand the control of AC drives.

TEXT BOOKS:

1. M.H.Rashid , Power Electronics,P.H.I. /Pearson, New Delhi, 2002, 2^{nd} Edition
2. Ned Mohan, Tore M. Undeland, and William P. RobinsPower Electronics - Converters, Applications and Design, , John Wiley and Sons,, 3^{rd} Edition

REFERENCE BOOK/WEBSITE LINKS:

1. G.K. Dubey, S.R. Doradla, A. Joshi and R.M.K. Sinha, Thyristorised Power Controllers, New Age International Publishers.
2. R.S. Ananda Murthy and V. Nattarasu, Power Electronics- A Simplified Approach,Sanguine Technical Publishers,2013
3. J.M. Jacob Thomson, Power Electronics, Principles and Applications, Vikas Publications, 2010.
4. M.D. Singh and Khanchandani K.BPower Electronics,Tata.Mc.Hill., 2015
5. . https://onlinecourses.nptel.ac.in

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*							*	
CO2	*		*	*	*							
CO3				*						*	*	*
CO4		*	*	*	*							*
CO5	*			*	*						*	*

DR. AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU – 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMESTER		
Course Title : LINEAR ICS AND APPLICATIONS		
Course Code : 18EE45	No. of Credits:3; L:T:P - 2:2:0	No. of hours/week: 4
Exam Duration: 3 hrs.	Marks: CIE + Assignment + GA + SEE = **40 + 5 + 5 + 50 = 100**	Total No. of Contact Hours: 39+12

Course Objective:

1. To acquaint the students with the basic characteristic and operation of op-amp and frequency response of op-amp.
2. To enable students to apply op-amp in AC amplifier circuits.
3. To design & analyze different linear, non-linear & mathematical application circuits using op-amp.
4. To learn some special applications of op-amps in integrated circuits.

Unit No.	Syllabus Content	No. of Hours
1	**a) Introduction:** Operational amplifier description- Circuit symbol and terminals block diagram. Basic op-amp parameters - Input and output voltage range, offset voltage and current, offset nulling, CMRR, PSRR, input and output impedance. **b) OP-Amps as AC Amplifiers:** Capacitor-Coupled voltage follower, High Z_{in} Capacitor Coupled voltage follower, Capacitor-Coupled non-inverting amplifier, High Z_{in} Capacitor Coupled non-inverting amplifier, Capacitor-Coupled inverting amplifier, setting upper cut off frequency, use of single polarity supply.	11
2	**a) OP-Amp Frequency Response And Compensation:** Circuit stability, Frequency and phase response, Frequency compensating methods, Band width, slew rate effects, stray capacitance effects, load capacitance effects, Z_{in} mod compensation, and circuit stability precautions **b) Signal Processing Circuits:** Introduction, saturating precision half wave rectifier, non-saturating half wave precision rectifier, two output precision half wave rectifier, precision full wave rectifier using half wave rectifier and summing circuit, high input impedance full wave precision rectifier, peak clipper, dead zone circuit, precision clipper, precision clamping circuit, precision rectifier peak detector, voltage follower peak detector, sample and hold circuit.	11
3	**a) OP-Amp Nonlinear Circuits:** Op-amps in switching circuits, zero crossing detectors, Inverting & Non inverting Schmitt trigger circuits, Astable multivibrator and monostable multivibrator. **b) Signal Generators:** Triangular wave generator, rectangular wave generator, phase shift oscillator, Wien bridge oscillator.	10
4	**Active Filters:** First order low pass active filter, second order low pass active filter, first order high pass active filter, second order high pass active filter, band pass filter, band stop filter.	10
5	**a) DC Voltage Regulators:** Basic linear voltage regulator, fixed output voltage regulators , adjustable output regulator(LM317/LM337), IC voltage regulators(IC723) **b) Specialized IC Applications:** Basics of universal active filter, basic phase lock loops, power amplifiers.	10

Course Outcome: At the end of the course students will be able to -
CO1: Recall the basics of op-amp.
CO2: Understand the behavior of op-amp linear and non- linear circuits.
CO3: Understand the operation of op-amp in signal processing and oscillator circuits.
CO4: Analyze the application of op-amp in nonlinear circuits.
CO5: Design a circuit or system using integrated circuits.

TEXT BOOKS:

1. David A Bell, "Operational amplifiers and linear ICs**",** 3rd edition, Oxford University Press, 2010.
2. B.Somanathan Nair, "Linear Integrated Circuits - Analysis, Design and Applications", 1st Edition, Wiley India, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. S. Salivahanan, V S KanchanaBhaaskaran, "Linear Integrated Circuits", 2nd Edition, McGraw Hill, 2015.
2. Stanley William D, **"**Operational amplifiers with Linear Integrated Circuits", 4th edition, Pearson Education.
3. Ramakanth A Gayakwad, "Operational amplifiers and linear ICs", 4th edition, PHI, 2009.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1		*			*						*	
CO2	*	*	*	*								
CO3	*	*	*	*								
CO4		*	*	*	*		*					
CO5	*	*	*	*	*						*	

Course Title : **TRANSFORMERS AND INDUCTION MACHINES LAB**		
Course Code : **18EEL47**	No. of Credits:1; L:T:P - **0:0:1**	No. of hours/week:**2**
Exam Duration: **3 hrs.**	Marks: CIE + SEE = **50+ 50 = 100**	

Course Objective:

1. To introduce various tests on Transformer, poly-phase Induction Machines, single-phase Induction Motor and evaluation of their performance.
2. To perform parallel operation of two dissimilar transformers for load sharing and verify analytically.
3. To learn various methods of speed control of Induction motor.
4. To study the connection of single phase transformers for three phase operation and phase conversion.

Unit No.	**Syllabus Content**
1	(a) Predetermination of efficiency and regulation by open circuit and short circuit tests on single - phase transformer. (b) Calculation of equivalent circuit parameters from the test data and determination of efficiency, regulation from the equivalent circuit to correlate results obtained earlier.
2	Sumpner's test on similar transformers and determination of combined and individual transformer efficiency
3	Parallel operation of two dissimilar (different kVA) single-phase transformers and determination of load sharing and analytical verification given the open circuit and short circuit test details.
4	Connection of 3 single-phase transformers in star - delta, delta -star and determination of efficiency under balanced and unbalanced resistive load.
5	Scott connection with balanced and unbalanced resistive loads.
6	Load test on 3-phase induction motor and determination of performance characteristics.
7	No load and blocked rotor tests on 3-phase induction motor, Predetermination of performance from circle diagram.
8	Speed control of 3-phase induction motor by varying rotor resistance.
9	Load test on - induction generator.
10	Load test on single- phase induction motor.
11	Polarity test on Transformers*
12	Determination of parameters of equivalent circuit of a 3-phase induction motor *
	*Experiments beyond syllabus

Course Outcome: At the end of the course students will be able to -
CO1: Conduct various tests on single-phase transformer and evaluate their performance
CO2: Conduct various tests on Poly-phase induction machines and single-phase induction motor to evaluate their performance.
CO3: Operate two dissimilar transformers in parallel for different load sharing.
CO4: Experiment the various methods of speed control of Induction motor.
CO5: Connect and evaluate the performance of single phase transformers for three phase operation and phase conversion.

REFERENCE: Laboratory manual

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*				*			*	*	*	*	
CO2	*				*			*	*	*	*	
CO3	*			*	*				*	*	*	
CO4	*			*	*				*	*	*	
CO5	*				*							

Course Title : POWER ELECTRONICS LAB		
Course Code : **18EEL47**	No. of Credits:**1;** L:T:P **-0:0:1**	No. of hours/week**: 2**
Exam Duration**: 3 hrs.**	CIE + SEE =**50 + 50 = 100 Marks**	

Course Objective:

1. To learn observe the characteristics of Power semiconductor devices practically.
2. To implement the controllable switches in different power electronic converter circuits for applications such as speed control of electrical machines and practical loads.

Unit No.	**Syllabus Content**
	Introduction to laboratory and data sheets of devices
1	Static characteristics of SCR.
2	Static characteristics of MOSFET and IGBT.
3	SCR turn-on circuit using UJT relaxation oscillator.
4	SCR Digital triggering circuit for single phase controlled rectifier.
5	Single-phase full-wave rectifier with *R* and *R-L* loads, with and without freewheeling diode
6	A.C. voltage controller using TRIAC – DIAC/UJT combination connected to *R* load
7	Speed control of a stepper motor.
8	Speed control of a universal motor / single-phase induction motor using A.C. voltage
9	Speed control of a separately excited D.C. motor using an IGBT/ MOSFET chopper.
10	MOSFET /IGBT based single-phase full-bridge inverter connected to R load.
11	Simulate the dynamic characteristics of (i) MOSFET (ii) IGBT (iii) BJT *
12	For given dv/dt ratings, design a snubber circuit and observe the response of the circuit by* simulation
13	Study the performance of SCR forced commutating circuits.— (i) By reducing the forward current below the holding current (current commutation) (ii) By applying a large reverse voltage across conducting SCR (Voltage commutation) *
	* - Experiments beyond syllabus

Course Outcome: The student will have,
CO1. An ability to understand basic operation of various power semiconductor devices and passive components.
CO2. An ability to understand the basic principle of switching circuits.
CO3. An ability to analyze and design an AC/DC rectifier circuit.
CO4. An ability to analyze and design DC/DC converter circuits.
CO5. An ability to analyze DC/AC inverter circuit.

REFERENCES:

1. Power Electronics, M.H.Rashid, 2nd Edition, P.H.I. /Pearson, New Delhi, 2002.
2. Power Electronics – Converters, Applications and Design, Ned Mohan, Tore M. Undeland, and William P. Robins,Third Edition, John Wiley and Sons.
3. Laboratory Manual

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*		*			*	*		*
CO2		*	*	*	*					*		
CO3	*		*		*	*			*			
CO4		*		*		*				*		
CO5	*	*	*	*	*	*			*	*		*

Dr. Ambedkar Institute of Technology, Bengaluru-560 056

SCHEME OF TEACHING AND EXAMINATION for **Batch: 2017**, Academic Year: 2019-20

B.E Programme: Electrical & Electronics Engineering

Outcome Based Education (OBE) and Choice Based Credit System (CBCS) **V SEMESTER**

CODE NO.	COURSE	CONTACT HOURS/WEEK			CREDITS	MAXIMUM MARKS		
		LECTURE	TUTORIAL	LAB		CONTINUOUS INTERNAL EVALUATION	SEMESTER END EVALUATION	TOTAL
HS03	Management And Entrepreneurship	4	0	0	4	50	50	100
EE51	Signal & Systems	2	2	0	3	50	50	100
EE52	Power Electronics-II	3	0	0	3	50	50	100
EE53	DC Machines & Synchronous Machines	4	0	0	4	50	50	100
EE54x	Elective - A	3	0	0	3	50	50	100
EE55x	Elective - B	4	0	0	4	50	50	100
EEL56	Control Systems Lab	0	0	3	1.5	50	50	100
$	Inter Department Elective	4	0	0	4	50	50	100
EEL57	Power Electronics Lab	0	0	3	1.5	50	50	100
EEL58	Simulation Lab	0	0	2	1	50	50	100
TOTAL		21	2	6	25	450	450	900

Elective- Group A (3 credits each)		**Elective- Group B (4 credits each)**	
EE541	Advanced Instrumentation System	EE551	VLSI Circuits & Design
EE542	Embedded Systems	EE552	Operating System
EE543	Modern Control Theory	EE553	Linear IC's and Applications

Inter Department Electives: Students who have not completed the IDE should register for the completion of 200 credits. According to section 16.2, Academic Regulations of Dr AIT, the credits registered should not exceed 30.

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : SIGNALS AND SYSTEMS		
Course Code : EE51	No. of Credits:3; L:T:P - 2:2:0	No. of hours/week: 2 + 2
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 26+26

Course Objective:

1. To learn the different types of signals and properties of Signals & Systems, convolution for LTI systems.
2. To visualize the relationship between the continuous-time, discrete-time Fourier series and Fourier transform of a signal.
3. To learn the applications of Fourier Transform.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction:** Definition of a signal and system, overview of systems, classifications of signals, basic operation on signals, elementary signals and systems viewed as interconnection of operations, properties of systems.	07
2	**Time Domain Representation For LTI Systems (Continuous & Discrete)**: Convolution, impulse response representation, properties of impulse response representation, solution of differential & difference equations, block diagram representation.	09
3	**Frequency Domain Representation of Signals and its Applications**: Introduction, Fourier representation of continuous-time periodic signals, properties of CTFS (excluding derivation of defining equations for CTFS), Fourier representation of discrete-time periodic signals, properties of DTFS (excluding problems on DTFS)	07
4	**a)Continuous-Time Fourier Transform:** Representation of non-periodic signals, properties of continuous time Fourier transforms. **b)Application of Fourier Representation:** Frequency response of lti systems. Solution of difference equations using system function, sampling of continuous time signals & signal reconstruction.	09
5	**a)Discrete-Time Fourier Transform:** Properties of continuous time Fourier transform. **b)Applications:** Frequency response of LTI systems, solution of difference equations using system function.	07

Course Outcome: At the end of the course students will be able to -
CO1: Characterize and analyze the properties of CT and DT signals and systems
CO2: Analyze LTI CT and DT systems in time domain using convolution.
CO3: Analyze systems for discrete-time (DT) and continuous-time (CT) signals;
CO4: Represent CT and DT systems in the Frequency domain using Fourier analysis tools.
CO5: Analyze Fourier transform for differential & difference equation applications.

TEXT BOOKS:

1. Simon Haykin and Barry VamVeen, “Signals & Systems”, John Wiley & Sons, 2001. Reprint 2002.
2. Alan V Oppenheim, Alan Willsky and S. Hamid Nawab “Signals & Systems” Pearson Education Asia, 2nd edition 1997. Indian Reprint 2002.

REFERENCE BOOK/WEBSITE LINKS:

1. P Ramakrishna Rao and Shankar Prakriya, “Signals & Systems”, McGraw Hill, 2nd edition.
2. J B Gurung, “Signals & Systems”, PHI, 2015.
3. Dr. D Ganesh Rao and SatishTunga, “Signals& Systems”, Sanguine Technical Publishers, 5th edition.
4. Michael J Roberts, “Signals & Systems Analysis of signals through linear systems” Tata McGraw Hill, 2003.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*						*		*		*
CO2	*	*						*		*		*
CO3	*	*						*		*		*
CO4	*	*						*		*		*
CO5	*	*						*		*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : POWER ELECTRONICS -II		
Course Code : EE52	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. Understand the speed control and braking methods of electrical drives for day to day applications.
2. Analyze the performance of converter fed DC and Induction motors along with speed torque characteristics.
3. Explain various speed - torque control techniques for industrial applications.
4. Design the modeling of drives in open loop and closed loop condition to justify their applications.

Unit No.	Syllabus Content	No. of Hours
1	**a) Introduction: C**oncept of electrical drives, classification **b) Dynamics of Electrical Drives:** Types of loads, quadrantal diagram of speed-torque characteristics, Load torques that vary with angle of displacement and time, dynamics of motor-load combination, Determination of Moment of inertia, Steady state stability of an Electric drive, Transient stability of an Electric Drive	**12**
2	**Starting :** Effect of starting power supply, motor and load, methods of starting electric motors, energy relations during starting, methods to reduce the energy loss during starting	**10**
3	**Braking :** Types, braking of dc motors during lowering of loads, braking of induction motors and induction motors, energy relations during braking, dynamics of braking	**12**
4	**Introduction to solid state controlled drives :** DC Motor systems, AC motor systems, brushless dc motors, switched reluctance motors, stepper motor	**10**
5	**Industrial Applications** Steel mills, paper mills, cement mills, textile mills, electric traction, coal mining.	**8**

Course Outcome: At the end of the course students will be able to -

CO1: Understand the dynamics of Electrical Drives

CO2: State and understand the starting methods of electric drives for day today applications

CO3: State and understand the braking methods of electric drives for day today applications

CO4: Understand the types of motors involved in solid state controlled drives

CO5: Analyze the types of motors in industrial applications

TEXT BOOKS:

1. S. K Pillai, A First course on Electrical Drives , New age international publishers
2. G K Dubey, Fundamentals of electric drives , Narosa Publications,1995

REFERENCE BOOK/WEBSITE LINKS:

1. Ned Mohan, Tore M. Undeland, and William P. Robins, Power Electronics - Converters, Applications and Design, John Wiley and Sons, .Third Edition,
2. G.K. Dubey, Power Semi-conductor drives.
3. R Krishnan, Electric motor drives – Modelling, Analysis and Control, Pearson.
4. Shepherd Hulley, Power Electronics and Motor control ,Cambridge University Press,2nd Edition,
5. P C Krause, Analysis of Electric machinery and drive systems,IEEE presses, 2ndEdition.
6. .M.D. Singh and Khanchandani K.B Power Electronics, Tata.Mc.Hill. 2012.
7. .M.H.Rashid, Power Electronics, P.H.I. /Pearson, New Delhi, 2002, 2nd Edition.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*								
CO2	*		*	*							*	
CO3			*	*	*							
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : DC Machines and Synchronous Machines		
Course Code : EE53	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. To gain knowledge on construction and working of DC machines and synchronous machines.
2. To study characteristics of DC machines and synchronous machines
3. To study various methods of testing, losses and efficiency of DC machines.
4. To analyze various methods of determining voltage regulation of a synchronous generator.
5. To analyze the operation of a synchronous machine (both as a generator and motor).

Unit No.	Syllabus Content	No. of Hours
1	**DC generator**: Review of basics of DC machines, classification of DC generator, types of armature winding, emf equation, no-load characteristic, armature reaction, load characteristics. Commutation, types of commutation, commutation difficulties, interpoles, compensating winding and equalizer rings (only qualitative treatment). Classification of DC motors, back emf and its significance, torque equation, characteristics of shunt, series & compound motors, speed control of shunt and series motors. Application of DC motors.	10
2	**a) Losses and efficiency:** losses in dc machines, power flow diagram, efficiency, condition for maximum efficiency. **b)Testing of dc machines**: direct & indirect methods of testing of dc machines-brake test, swine burn’s test, Hopkinson’s test, retardation test, field’s test, merits and demerits of tests.	10
3	**Synchronous machines:** Basic principle of operation, construction of salient & non-salient pole synchronous machines, generated EMF, effect of distribution and chording of winding, harmonics-causes, reduction and elimination. Armature reaction, synchronous reactance, leakage reactance, phasor diagram of non-salient type alternator.	10
4	**Voltage Regulation**: Voltage regulation by EMF, MMF, ZPF & ASA method. Short circuit ratio and its importance. Two reaction theory-direct and quadrature axis reactances, phasor diagram. Slip test and regulation.Synchronizing to infinite bus bars, parallel operation of alternators. Operating characteristics, power angle characteristics excluding armature resistance, operation for fixed input and variable excitation.	12
5	**a) Synchronous motor:** Principle of operation, phasor diagrams, torque and torque angle, Blondel diagram, effect of change in load, effect of change in excitation, ‘V’ and ‘inverted V curves’. Synchronous condenser, hunting and damping. Methods of starting of synchronous motors. **b)Special DC motors**: Permanent magnet motors, brushless DC motors. Applications.	10

Course Outcome: At the end of the course students will be able to -
CO1. Explain constructional features and phenomena related to DC, synchronous machines and special machines. (L1)
CO2. Explain the operation, characteristics and performance to DC, synchronous machines and special machines. (L2)
CO3. Solve problems related to speed control, losses and efficiency of DC machines.(L3)
CO4. Analyze the behavior of synchronous machines in parallel and on infinite busbars.(L4)
CO5. Evaluate voltage regulation of synchronous generators by various methods. (L5)

TEXT BOOKS:
1. Electrical Machinery: DP Kothari, I.J.Nagarath, TMH, 4th edition, 2010.

REFERENCE BOOK/WEBSITE LINKS:
1. Performance& Design of Alternating Current machines**:** M. G. Say, CBS publishers, 3rd Edition, 2002.
2. The Performance & Design of DC machines: A.E Clayton &N.N.Hancock CBS Publication, 3rd Edition, 2004.
3. Electrical Machines: Ashfaq Hussain, Dhanpat Rai Publications.
4.Electrical Machines:P.S Bhimbra, Khanna Publishers
5. Electric Machines: Mulukuntla.S.Sarma, Mukesh.K.Pathak, Cengage Learning, First edition, 2009.
6. Electric Machines: Ahhijit Chakrabarti, Sudipta Bebnath, McGraw Hill Education (India) Private Limited, New Delhi.

INSTRUCTIONS TO PAPER SETTERS
1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*	*		*					*
CO2	*	*	*	*	*		*					*
CO3	*	*	*	*	*		*					*
CO4	*	*	*	*	*		*					*
CO5	*	*	*	*	*		*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : CONTROL SYSTEMS LAB		
Course Code : EEL56	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

1. To study Transient and steady state behavior of linear control systems, study frequency and Time domain response characteristics of 2nd order systems.
2. To design compensating networks for improvement of stability, study AC/DC servomotor performance.

Unit No.	Syllabus Content
1	Simulation of a typical second order system and determination of step response and evaluation of time- domain specifications using a software tool
2	(a) Design of a passive RC lead compensating network for the given specifications, viz., the maximum phase lead and the frequency at which it occurs and to obtain its frequency response. (b) Experimental determination of transfer functions of a lead compensating network.
3	(a) Design of a RC lag compensating network for the given specifications. viz., the maximum phase lag and the frequency at which it occurs, and to obtain its frequency response. (b) Experimental determination of transfer functions of a lag compensating network.
4	Study of the effect of P, PI, PD and PID controller on the step response of a feedback control system (using control engineering trainer/process control simulator).
5	Speed – torque characteristic of a two - phase A.C. servomotor.
6	Speed torque characteristic of a D.C. servomotor.
7	Experimental determination of frequency response of a second -order system and evaluation of frequency domain specifications
8	Simulation of a D. C. position control system and its step response.
9	Determination of phase margin and gain margin of a transfer function by Bode Plots and verification by simulation.
10	Construction of root locus of transfer function and verification by simulation.
11	Synchro pair characteristics.

Course Outcome: At the end of the course students will be able to -

CO1: Understand and analyze the time and frequency domain specifications for a second order system.
CO2: Analyze the performance of servomotors.
CO3: Evaluating system performance using P,I,D controllers
CO4: Design the control system with compensators.
CO5: Use MATLAB for simulation and validation of results obtained by analytical calculations.

REFERENCES:

1.Matlab user manual, Ogata
2.Matlab by Rudrapratap

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*	*			*	*		*
CO2	*	*	*	*	*	*			*	*		*
CO3	*	*	*	*	*	*			*	*		*
CO4	*	*	*	*	*	*			*	*		*
CO5	*	*	*	*	*	*			*	*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : POWER ELECTRONICS LAB		
Course Code : EEL57	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

3. To learn observe the characteristics of Power semiconductor devices practically.
4. To implement the controllable switches in different power electronic converter circuits for applications such as speed control of electrical machines and practical loads.

Unit No.	Syllabus Content
	Introduction to laboratory and data sheets of devices
1	Static characteristics of SCR.
2	Static characteristics of MOSFET and IGBT.
3	SCR turn-on circuit using UJT relaxation oscillator.
4	SCR Digital triggering circuit for single phase controlled rectifier.
5	Single-phase full-wave rectifier with *R* and *R-L* loads, with and without freewheeling diode
6	A.C. voltage controller using TRIAC – DIAC/UJT combination connected to *R* load
7	Speed control of a stepper motor.
8	Speed control of a universal motor / single-phase induction motor using A.C. voltage
9	Speed control of a separately excited D.C. motor using an IGBT/ MOSFET chopper.
10	MOSFET /IGBT based single-phase full-bridge inverter connected to R load.
11	Simulate the dynamic characteristics of (i) MOSFET (ii) IGBT (iii) BJT *
12	For given dv/dt ratings, design a snubber circuit and observe the response of the circuit by* simulation
13	Study the performance of SCR forced commutating circuits.— (i) By reducing the forward current below the holding current (current commutation) (ii) By applying a large reverse voltage across conducting SCR (Voltage commutation) *
	* - Experiments beyond syllabus

Course Outcome: The student will have,
CO1. An ability to understand basic operation of various power semiconductor devices and passive components.
CO2. An ability to understand the basic principle of switching circuits.
CO3. An ability to analyze and design an AC/DC rectifier circuit.
CO4. An ability to analyze and design DC/DC converter circuits.
CO5. An ability to analyze DC/AC inverter circuit.

REFERENCES:

1. Power Electronics, M.H.Rashid, 2nd Edition, P.H.I. /Pearson, New Delhi, 2002.
2. Power Electronics – Converters, Applications and Design, Ned Mohan, Tore M. Undeland, and William P. Robins, Third Edition, John Wiley and Sons.
3. Laboratory Manual

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*		*			*	*		*
CO2		*	*	*	*					*		
CO3	*		*		*	*			*			
CO4		*		*		*				*		
CO5	*	*	*	*	*	*			*	*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 **ELECTRICAL AND ELECTRONICS ENGINEERING** **V SEMSTER**		
Course Title : SIMULATION LAB		
Course Code : EEL58	No. of Credits:1; L:T:P -0:0:1	No. of hours/week: 2
Exam Duration: 3 hrs.	CIE + SEE =+ 50 = 100 Marks	

Course Objective:

1. To simulate different analog, digital and power electronics circuits.
2. To implement the circuits used for measurement using software package.

Unit No.	Syllabus Content
1	a) Inverting, non-inverting & scale changing of signals using op-amps b) RC phase shift oscillator using op amps (Both using Pspice package)
2	RC coupled amplifier-frequency response for variation in bias & coupling using Pspice simulation package
3	Rectifier circuits-Bridge rectifier, diode clipping & clamping circuits using Pspice simulation package.
4	Schmitt –trigger- inverting and non-inverting using Pspice simulation package.
5	Signal generator- triangular, saw tooth and rectangular wave generation using Pspice simulation package.
6	Simulation of Thevinin's theorem using Pspice simulation package.
7	Simulation of Super-position theorem using Pspice simulation package.
8	Simulation of Encoder using Pspice simulation package.
9	Simulation of Decoder using Pspice simulation package.
10	Simulation of MUX using Pspice simulation package.
11	Simulation of DEMUX using Pspice simulation package.
12	Simulation of 3- phase controlled rectifier using MATLAB
13	Simulation of 3- phase un-controlled rectifier using MATLAB

Course Outcome: At the end of the course students will be able to -

CO1: understand the importance of simulation studies with respect to digital circuits.
CO2: Learn the importance of simulation studies with respect to analog circuits.
CO3: To perform simulation studies with respect to power electronic circuits.
CO4: To analyze electrical circuits using simulation software.
CO5: Design circuits using MATLAB and PSPICE software for simulation.

REFERENCES:
1. Laboratory manual
2. PSpice User Manual
3. MATLAB user manual.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*	*	*			*	*		*
CO2	*	*	*	*	*	*			*	*		*
CO3	*		*						*	*		*
CO4		*		*	*				*	*		
CO5	*	*	*	*	*				*	*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : ADVANCED INSTRUMENTATION SYSTEM		
Course Code : EE541	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. To expose Instrumentation, as a Technology of measurement.
2. To study various Measurement Techniques measuring instruments.
3. To study the construction and working of various Transducers.
4. To study the design and applications of Data Acquisition systems.
5. To understand some standard data Transmission systems.

Unit No.	Syllabus Content	No. of Hours
1	**Instrumentation:** Frequency Meter, Measurement of Time and Frequency (Mains), Tachometer, Phase Meter, Capacitance Meter. Automation in Digital Instrumentation.	07
2	**Measuring Instruments:** Output Power Meters, Field Strength Meter Vector Impedance Meter, Q Meter Applications-Z, Z_0 And Q. Basic LCR Bridge, RX Meters**.**	10
3	**Transducers:** Synchronous, Capacitance Transducers, Load Cells, Piezo Electrical Transducers, IC Type Temperature Sensors, Pyrometers, Ultrasonic Temperature Transducer, Reluctance Pulse Pick-Ups.	10
4	**Data Acquisition And Conversion:** Generalized Data Acquisition System (DAS), Signal Conditioning of Inputs, Single Channel DAS, Multi-Channel DAS, Data Loggers, Compact Data Logger.	07
5	**Data Transmission:** RS-232 Standard, Universal Serial Bus, IEEE-1394.Long Distance Data Transmission (Modems).IEEE 488 Bus. Electrical Interface.	05

Course Outcome: At the end of the course students will be able to -

CO1: To study the principle, construction and working of digital instruments and understand the use of automation in digital instrumentation, harmonic and wave analyzers.

CO2: To understand the telemetry systems and get brief insight of various transmission methods used in Industry.

CO3: To understand transducers for usable output (analog, digital or frequency modulated) in response to specified input measurands (Physical/mechanical etc.).

CO4: Understand data acquisition systems and measurement of power at RF and microwave frequencies.

CO5:Understand the instruments that exist in remote places and transmit over long distances to a master control room

TEXT BOOKS:

1. Electronic Instrumentation. H S Kalsi, TMH, 3rd Edition, 2010.
2. Modern Electronic Instrumentation and Measuring Techniques. Cooper D and A D Helfrick, PHI, 2009

REFERENCE BOOK/WEBSITE LINKS:

1. Instrumentation reference book. Fourth edition, Walt boyes , Elsevier publishes 2010
2. Student Reference Manual for Electronic Instrumentation Laboratories.
Stanly Wolf, Richard F H, Smith, PHI, 2nd Edition, 2010
3. http://www.unb.ca/cel/online/courses-programs/open-entry/engineering-ee6913.html
4. Spectrum.ieee.org

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*			*				*	*		
CO2	*	*			*				*			*
CO3	*				*	*	*			*		*
CO4	*	*	*			*		*			*	*
CO5						*	*	*			*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 **ELECTRICAL AND ELECTRONICS ENGINEERING** **VII SEMESTER**		
Course Title : EMBEDDED SYSTEMS		
Course Code : EE542	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. Understand embedded system and real time systems.
2. Real-time systems: Identify the unique characteristic, explain general structure and define the unique design problems and challenges of real-time system
3. Understand basics, program, design, implement and test an embedded system.

Unit No.	Syllabus Content	No. of Hours
1	**Concept of Embedded System Design:** Components, classification, skills required. Embedded Micro controller cores, Architecture of 6808 and 6811. Embedded Memories ROM variants and RAM. Applications of embedded system: Examples of Embedded systems.	07
2	**Technological Aspects of Embedded System:** Interfacing between analog and digital blocks, Signal conditioning, digital signal processing, DAC & ADC interfacing, Signal conditioning using DSP.	09
3	**Design Trade Offs Due to Process Incompatibility, Thermal Considerations:** Issues in embedded system design. Design challenge, design technology, tradeoffs. Thermal considerations.	07
4	**Software Aspects of Embedded Systems**: Real time programming languages, operating systems. Programming concepts and embedded programming in C. Round Robin, Round Robin with interrupts, Real time OS architecture, Selecting architecture. Introduction to RTOS.	09
5	**Subsystem Interfacing**: External system, user interfacing and Serial I/O devices, Parallel port interfaces: Input switches, Key boards and Memory interfacing. **Case Study:** Embedded velocity PID controller, PI controller with a PWM actuator.	07

Course Outcome: At the end of the course students will be able to -
CO1: To learn the concept of embedded microcontroller cores, architecture and application of embedded system.
CO2: To understand technological aspects of interfacing between analog and digital blocks.
CO3: Embedded system design issues in compatibility are to be understood.
CO4: To learn the method of designing a real time system.
CO5: To learn the technological hardware of embedded system aspects.

TEXT BOOKS:

1. Embedded Microcomputer systems: Real time interfacing. Valvano, J.W, Cengage Learning, 2nd Edition 5th Indian reprint,2009
2. The Art of Designing Embedded Systems. Ganssle, Jack, Newness
3. Embedded System, Architecture, Programming and Design. Raj Kamal, TMH, 2nd Edition 2008.

REFERENCE BOOK/WEBSITE LINKS:

1A Unified Hardware/Software Introduction. Frank Vahid/Tony Givargis, Wiley student edition 2002

2Motorola and Intel Manuals

3Embedded Software Premier. Simon David, Addison Wessly 2000

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 2 and 3 and questions 5 and 6 are to be from unit 2 and unit 4 respectively. Students have to answer Q.2 or Q.3 and Q.5 or Q.6.

3. Questions 1, 4 and 7 are to be set from units 1, 3 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*										
CO2			*	*	*							
CO3					*		*					
CO4									*	*		
CO5											*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : MODERN CONTROL THEORY		
Course Code : EE543	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. Students would be able to design and analyze the system in industrial control.
2. Student will get familiar with advanced applications of control system.

Unit No.	Syllabus Content	No. of Hours
1	**State Variable Analysis And Design**: Introduction, concept of state, state variables and state model, state modeling of linear systems, linearization of state equations. State space representation using physical variables, phase variables & canonical variables.	8
2	**Derivation of transfer function from state model**, Diagonalization, Eigen values, Eigen vectors, generalized Eigen vectors. Solution of state equation, state transition matrix and its properties, computation using Laplace transformation.	8
3	**Concept of controllability & observability**, methods of determining the same, effect of pole zero cancellation, duality.	7
4	**Pole Placement Techniques**: stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design.	8
5	**Non-linear systems**: Introduction, behavior of non-linear system, common physical non linearity-saturation, friction, backlash, dead zone, relay, multi variable non-linearity. Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories.	8

Course Outcome: At the end of the course students will be able to -
CO1: Understand the fundamentals of state variables, linear and nonlinear systems.
CO2: Analyze SISO and MIMO systems and obtain the state models.
CO3: Application of Eigen values for derivation of transfer functions.
CO4: Perform analysis on Controllability and Observability.
CO5: Improve stability of a given system by state feedback pole placement techniques

TEXT BOOKS:

1. Digital control & state variable methods. M. Gopal , 3rd Edition, TMH ,2008
2. Control system Engineering. I. J. Nagarath& M. Gopal, New Age International (P) Ltd, 3rd edition.

REFERENCE BOOK/WEBSITE LINKS:

1. State Space Analysis of Control Systems**.** Katsuhiko Ogata -PHI
2. Automatic Control Systems**.** Benjamin C. Kuo&FaridGolnaraghi, 8th edition, John Wiley & Sons 2009.
3. Modern Control Engineering. Katsuhiko Ogata, PHI,5th Edition, 2010
4. Modern Control Engineering. D. Roy Choudary, PHI, 4th Reprint, 2009.
5. Modern control systems. Dorf& Bishop- Pearson education, 11th Edition 2008

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*								*		*
CO2	*	*				*				*		*
CO3	*	*				*				*		*
CO4	*	*				*				*		*
CO5	*	*				*				*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : VLSI CIRCUIT DESIGN		
Course Code : EE551	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To introduce the present technology applied in the MOS Fabrication and to design and analyze the basic electrical properties of various transistors and its electrical equivalent models
2. To teach the students regarding the classical representations of the various transistors and to enable the electrical engineers to calculate the circuit parameters involved in the scaling process.
3. Issues arising during the architectural and structural design of a basic sequential and clocked circuit is discussed

Unit No.	Syllabus Content	No. of Hours
1	**A Review Of Microelectronics And An Introduction To MOS Technology:** Introduction To Integrated Circuit Technology. Introduction, VLSI Technologies, MOS Transistors, Fabrication, Thermal Aspects, Production Of E-Beam Masks.	10
2	**Basic Electrical Properties Of MOS And BICMOS Circuit:** Drain To Source Current I_{ds} Versus V_{ds} Relationships- BICMOS Latch Up Susceptibility. MOS Transistor Characteristics, Figure Of Merit, Pass Transistor NMOS And CMOS Inverters, Circuit Model, Latch Up In CMOS Circuits.	11
3	**a) MOS And BICMOS Circuit Design Processes:** MOS Layers, Stick Diagrams, Design, Symbolic Diagrams. **b) Basic Circuit Concepts And Scaling Of MOS Circuits:** Sheet Resistance, Capacitance Layer Inverter Delays, Wiring Capacitance, Choice Of Layers. Scaling Model And Scaling Factors- Limitations Due To Current Density.	11
4	**Subsystem Design And Layout:** Architectural Issues, Systems Considerations. Examples Of Structural Design, Clocked Sequential Circuits.	10
5	**a) Subsystem Design Processes: G**eneral Considerations, Illustration Of Design Process, Observations. **b) Illustration Of The Design Process:** Observation On The Design Process, Regularity Design Of An ALU Subsystem. Design Of 4-Bit Adder, Implementation Of ALU Functions.	10

Course Outcome: At the end of the course students will be able to -
CO1: Students will be aware of the present MOS technology.
CO2: Understand different properties of MOS and BICMOS circuits.
CO3: Understand the design process of MOS and BICMOS circuits along with scaling of MOS circuits.
CO4: To understand subsystem design and layout.
CO5: To understand the process of subsystem design.

TEXT BOOKS:

1. Basic VLSI Design. Douglas Pucknell & Eshragian, PHI, 3rd Edition, 2009.
2. Fundamentals of Modern VLSI Devices. Yuan TaunTak H Ning Cambridge Press, South Asia Edition 2003.

REFERENCE BOOK/WEBSITE LINKS:

1. Modern VLSI Design. Wayne wolf, Pearson Education Inc. 3rd edition, 2003.
2. Introduction to CMOS VLSI Design-A Circuits and Systems Perspective. Neil Weste, Pearson Education. 3rd Edition.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*					*		*
CO2	*	*	*	*	*					*		*
CO3	*	*	*	*	*					*		*
CO4	*	*	*	*	*					*		*
CO5	*	*	*	*	*					*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : OPERATING SYSTEMS		
Course Code : EE552	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To make the students understand about the computer organizations including its subsidiary systems, the concept of system management with various process controls methods.
2. To explain the students about the need of synchronization and to overcome the deadlocks and to familiarize the use of various memory and their Accessibility in the operating system operations.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction To Operating System, System Structures:** What Operating System Do; Computer System Organization; Computer System Architecture; Operating System Structure; Operating System Operations; Process Management; Memory Management; Storage Management; Protection And Security; Distributed System; Special Purpose Systems; Computing Environments. Operating System Services; User - Operating System Interface; System Calls; Types Of System Calls; System Programs; Operating System Design And Implementation; Operating System Structure; Virtual Machines; Operating System Generation; System Boot.	11
2	**Process Management:** Process Concept; Process Scheduling; Operations On Processes; Inter-Process Communication. Multi-Threaded Programming: Overview; Multithreading Models; Thread Libraries; Threading Issues. Process Scheduling: Basic Concepts; Scheduling Criteria; Scheduling Algorithms; Multiple-Processor Scheduling; Thread Scheduling.	10
3	**a) Process Synchronization:** Synchronization: The Critical Section Problem; Peterson's Solution; Synchronization Hardware; Semaphores; Classical Problems Of Synchronization; Monitors. **b) Deadlocks:** Deadlocks: System Model; Deadlock Characterization; Methods For Handling Deadlocks; Deadlock Prevention; Deadlock Avoidance; Deadlock Detection And Recovery From Deadlock.	10
4	**a) Memory Management:** Memory Management Strategies: Background; Swapping; Contiguous Memory Allocation; Paging; Structure Of Page Table; Segmentation. Virtual Memory Management: Background; Demand Paging; Copy-On-Write; Page Replacement; Allocation Of Frames; Thrashing. **b) File System, Implementation Of File System:** File System: File Concept; Access Methods; Directory Structure; File System Mounting; File Sharing; Protection. Implementing File System: File System	11

	Structure; File System Implementation; Directory Implementation; Allocation Methods; Free Space Management.	
5	**Secondary Storage Structures, Protection:** Mass Storage Structures; Disk Structure; Disk Attachment; Disk Scheduling; Disk Management; Swap Space Management. Protection: Goals Of Protection, Principles Of Protection, Domain Of Protection, Access Matrix, Implementation Of Access Matrix, Access Control, Revocation Of Access Rights, Capability-Based Systems.	10

Course Outcome: At the end of the course students will be able to –
CO1: Explain about the basic operations and the phenomena involved in operating of operating systems.
CO2: Explain the working of various processes and the concept of multi-tasking.
CO3: Define the synchronization requirements and its importance during the operation
CO4: Justify the allocation of the memory for various tasks and its management
CO5: List out the importance of the need of secondary memory and to protect the basic OS principles.

TEXT BOOKS:
1. Operating System Principles. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Wiley, 8th Edition, 2009.

REFERENCE BOOK/WEBSITE LINKS:
1. Operating Systems: A Concept Based Approach. D.M Dhamdhere, TMH, 2nd Edition, 2006.
2. Operating Systems. P.C.P. Bhatt, PHI, 2nd Edition, 2008.
3. Operating Systems. Harvey M Deital, Pearson Education, 3rd Edition.

INSTRUCTIONS TO PAPER SETTERS
1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*					*		*
CO2	*	*	*	*	*					*		*
CO3	*	*	*	*	*					*		*
CO4	*	*	*	*	*					*		*
CO5	*	*	*	*	*					*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : LINEAR ICS AND APPLICATIONS		
Course Code : EE553	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. To acquaint the students with the basic characteristic and operation of op-amp and frequency response of op-amp.
2. To enable students to apply op-amp in AC amplifier circuits.
3. To design & analyze different linear, non-linear & mathematical application circuits using op-amp.
4. To learn some special applications of op-amps in integrated circuits.

Unit No.	Syllabus Content	No. of Hours
1	**a) Introduction:** Operational amplifier description-–Circuit symbol and terminals, block diagram. Basic op-amp parameters- Input and output voltage range, offset voltage and current, offset nulling, CMRR, PSRR, input and output impedance, slew rate **(no question shall be set from the introduction)** **b) OP-Amps as AC Amplifiers:** Capacitor-Coupled voltage follower, High Z_{in} Capacitor Coupled voltage follower, Capacitor-Coupled non-inverting amplifier, High Z_{in} Capacitor Coupled non-inverting amplifier, Capacitor-Coupled inverting amplifier, setting upper cut off frequency, use of single polarity supply. **c) OP-Amp Frequency Response And Compensation:** Op-amp circuit stability, frequency and phase response, frequency compensating methods, manufacturer's recommended compensation, slew rate effects, stray capacitance effects, load capacitance effects, Z_{in} mode compensation, circuit stability precautions.	12
2	**Signal Processing Circuits:** Introduction, saturating precision half wave rectifier, non-saturating half wave precision rectifier, two output precision half wave rectifier, precision full wave rectifier using half wave rectifier and summing circuit, high input impedance full wave precision rectifier, peak clipper, dead zone circuit, precision clipper, precision clamping circuit, precision rectifier peak detector, voltage follower peak detector, sample and hold circuit.	10
3	**a) OP-Amp Nonlinear Circuits:** Op-amps in switching circuits, zero crossing detectors, Inverting & Non inverting Schmitt trigger circuits, Astable multivibrator and monostable multivibrator. **b) Signal Generators:** Triangular wave generator, rectangular wave generator, phase shift oscillator, Wien bridge oscillator.	10
4	**Active Filters:** First order low pass active filter, second order low pass active filter, first order high pass active filter, second order high pass active filter, band pass filter, band stop filter.	10
5	**a) DC Voltage Regulators:** Basic linear voltage regulator, fixed output voltage regulators , adjustable output regulator(LM317/LM337), IC voltage regulators(IC723) **b) Specialized IC Applications:** Basics of universal active filter, basic phase lock loops, power amplifiers.	10

Course Outcome: At the end of the course students will be able to -
CO1: Recall the basics of op-amp.
CO2: Understand the behavior of op-amp linear and non- linear circuits.
CO3: Understand the operation of op-amp in signal processing and oscillator circuits.
CO4: Analyze the application of op-amp in nonlinear circuits.
CO5: Design a circuit or system using integrated circuits.

TEXT BOOKS:

1. David A Bell, "Operational amplifiers and linear ICs**",** 3rd edition, Oxford University Press, 2010.
2. B.Somanathan Nair, "Linear Integrated Circuits - Analysis, Design and Applications", 1st Edition, Wiley India, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. S. Salivahanan, V S KanchanaBhaaskaran, "Linear Integrated Circuits", 2nd Edition, McGraw Hill, 2015.
2. Stanley William D, **"**Operational amplifiers with Linear Integrated Circuits", 4th edition, Pearson Education.
3. Ramakanth A Gayakwad, "Operational amplifiers and linear ICs", 4th edition, PHI, 2009.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1		*			*						*	
CO2	*	*	*	*								
CO3	*	*	*	*								
CO4		*	*	*	*		*					
CO5	*	*	*	*	*						*	

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : POWER SYSTEMS ANALYSIS		
Course Code : EE61	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective: Students will learn to

1. Modeling of power system elements and representation the power system in single line diagrams.
2. Use symmetrical components in power system analysis.
3. Perform fault and stability analysis on power system network.
4. Evaluate the performance of induction machine under unbalanced supply conditions.

Unit No.	Syllabus Content	No. of Hours
1	**a) Representation of Power System Components:** Circuit models of transmission line, synchronous machines, transformers and load. Single line diagram, impedance and reactance diagrams. Per unit system, per unit impedance diagram of power system. **b) Symmetrical 3 - Phase Faults**: Transient, sub transient and steady state reactance's and currents of synchronous machines. Short-circuit currents of synchronous machines and power system.	11
2	**Symmetrical Components:** Introduction**,** three phase operator-**a**. Synthesis of unbalanced vector from its symmetrical components. Resolution of unbalanced phasors into their symmetrical components. Relation between Line & phase voltages in star connected system. Relation between Line & phase currents in delta connected system. Phase shift of symmetrical components in transformer banks. Power in terms of symmetrical component. Analysis of balanced and unbalanced loads against unbalanced 3 phases supply. Sequence networks of synchronous generators & transformers. Sequence networks of power system.	12
3	**Unsymmetrical Faults:** Single line to ground fault (LGF), line to line fault (LLF), double line to ground fault (LLGF): Determination of faults currents, terminal voltages, and connection of sequence networks. Fault on loaded synchronous generator. Fault with fault impedance. Unsymmetrical faults on power system.	10
4	**Concept of System Stability:** Introduction**,** classification of stability, steady state and transient stability. Power angle equation of salient and non-salient pole machines. Power angle curves. Stability limits and methods to improve stability. Rotor dynamics and the swing equation. Equal area criterion and critical clearing time. Apply equal area criterion for transient stability evaluation under different operating conditions of power system.	10
5	**Unbalanced Operation of Three Phase Induction Motors**: Open conductor faults in power system: sequence network connections.	09

	Analysis of three phase induction motor with one line open. Analysis of three phase induction motor with unbalanced supply.	

Course Outcome: At the end of the course students will be able to -

CO1: Recall the equivalent circuits of power system components and to draw the single line & impedance diagrams of power system network.

CO2: Apply concept of symmetrical components to power system network.

CO3: Analyze the behavior of power system under different fault conditions.

CO4: Evaluate the steady state and transient stability of the Power Systems.

CO5: Investigate the effect of unbalanced operation and single phasing on the Performance of three phase induction machines.

TEXT BOOKS:

1. W.D.Stevenson, Elements of Power System Analysis, TMH,4th Edition
2. I.J.Nagrath and D.P.Kothari- Modern Power System Analysis. TMH, 3rd Edition, 2003.

REFERENCE BOOK/WEBSITE LINKS:

1. Dr. P.N.Reddy, Symmetrical Components and Short Circuit Studies, Khanna Publishers.
2. HadiSadat, Power System Analysis. TMH, 2nd Edition.
3. R.Bergen, and Vijay Vittal Power system Analysis, Pearson publications, 2nd edition, 2006.
4. G.L. Kusic, Computer Aided Power system analysis. PHI.Indian Edition, 2010
5. W.D. Stevenson & Grainger, Power System Analysis. TMH, First Edition, 2003.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*						*			*
CO2	*	*	*	*								*
CO3	*	*	*						*			*
CO4	*	*	*			*					*	
CO5	*	*	*			*						*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : ELECTRICAL MACHINE DESIGN		
Course Code : EE62	No. of Credits: 4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To introduce the knowledge on basic principles of design, limitations and different materials used in electrical machines.
2. To understand the design concepts of static and rotating electrical machines.
3. To design and to interpret the design data of electrical machines.
4. To analyze design problems of machines/devices to satisfy the requirements.

Unit No.	Syllabus Content	No. of Hours
1	**a) Principles Of Electrical Machine Design:** Introduction, considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines. **b) Design Of Transformers (Single Phase and Three Phase):** Output equation for single phase and three phase transformers, choice of specific loadings, expression for volts/turn, determination of main dimensions of the core, types of windings and estimation of number of turns and conductor cross sectional area of primary and secondary windings.	12
2	**Estimation of Leakage Reactance and Tank Design of Transformers:** No load current, expression for leakage reactance and voltage regulation. Design of tank and cooling tubes (round and rectangular).	10
3	**Design of DC Machines:** Output equation, choice of specific loadings and choice of number of poles, design of main dimensions of the dc machines, design of armature slot dimensions, commutator and brushes, magnetic circuit - estimation of ampere turns, design of yoke and pole, field windings – shunt, series and inter pole.	10
4	**Design of induction Motors:** Output equation, choice of specific loadings, main dimensions of three phase induction motor, stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor, design of rotor bars and end ring, design of slip ring induction motor, estimation of no load current.	10
5	**Design of Synchronous Machines:** Output equation, choice of specific loadings, short circuit ratio, design of main dimensions, design of the field winding, armature slots and windings, slot details for the stator of salient and non-salient pole synchronous machines.	10

Course Outcome: At the end of the course students will be able to -
CO1: Define basic principles of design, merits and demerits.
CO2: Explain design concepts of power and distribution transformers.
CO3: Explain design concepts of AC and DC rotating electrical machines.
CO4: To solve the problems on design of power and distribution transformers.
CO5: To design the AC and DC rotating electrical machines.

TEXT BOOKS:

1. A.K. Sawhney, A Course in Electrical Machine Design. DhanpattRai& Sons
2. V. N. Mittle, Design of Electrical Machines., 4th edition.

REFERENCE BOOK/WEBSITE LINKS:

1. M.G. Say, Performance and design of AC Machines, CBS Publishers and Distributors Pvt. Ltd.
2. A. Shanmugasundarm, G. Gangadharan, R. Palani, Design Data Handbook. Wiley Eastern Ltd.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1		*	*									
CO2	*		*						*			*
CO3		*										*
CO4			*						*			*
CO5			*						*			*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : DIGITAL SIGNAL PROCESSING		
Course Code : EE63	No. of Credits:4; L:T:P - 3:2:0	No. of hours/week: 03+02
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To understand DFT and its properties,
2. To learn FFT algorithm to find DFT.
3. To understand the structure of IIR & FIR system and to learn Digital IIR filter design using analog filter transformation.
4. To learn Digital FIR filter design

Unit No.	Syllabus Content	No. of Hours
1	**Discrete Fourier Transforms:** Definitions, properties-linearity, shift, symmetry etc., circular convolution – periodic convolution, use of tabular arrays, circular arrays, Stockholm's method, linear convolution – two finite duration sequence, one finite & one infinite duration, overlap add and save methods**.**	8+5
2	**Fast Fourier Transforms Algorithms:** Introduction, decimation in time algorithm, number of computations, number of multiplications, computational efficiency, decimation in frequency algorithms, inverse decimation in time and inverse decimation in frequency algorithms, decomposition for a composite number N=9.	8+5
3	**Realization of Digital Systems:** Introduction, block diagrams and SFGs, realization of IIR systems- direct form, cascaded, parallel form, realization of FIR systems – direct form, cascade form, linear phase realization.	7+5
4	**Design of IIR Digital Filters:** Introduction, impulse invariant & bilinear transformations, all pole analog filters- Butterworth & Chebyshev, design of digital Butterworth & Chebyshev, frequency transformations.	8+5
5	**Design of FIR Digital Filters:** Introduction, windowing, rectangular, modified rectangular, Hamming, Hanning, Blackman window (excluding Kaiser window), frequency sampling techniques.	8+6

Course Outcome: At the end of the course students will be able to -

CO1. Analyze and find DFT of signals.
CO2. Analyze and find DFT using FFT algorithms.
CO3. Realize structures for FIR & IIR systems.
CO4. Design IIR filters for the given specifications.
CO5. Design FIR filters for the given specifications**.**

TEXT BOOKS:

1. Proakis,"Digital Signal Processing Principle, Algorithm & application", Pearson, 4th education, 2009.
2. Sanjeet. K. Mitra,"Digital Signal Processing". TMH, 3rd Edition, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. Johnny R. Johnson "Introduction to Digital Signal Processing", PHI, 2009.
2. Oppenheim, "Discrete Time Signal Processing "Pearson 2nd Edition 2009.
3. S.Salivahanan, A.Vallaraj, C.Gnanapriya"Digital Signal Processing", TMH, 2nd Edition, 2010.
4. Ifeachor Emmaue "Digital Signal Processing" l- Pearson education, 2nd Edition, 2006.
5. Ludeman, "Fundamentals of Digital Signal Processing". John Wiley, 3rd Edition, 2008

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*						*		*		*
CO2	*	*		*				*		*		*
CO3	*	*						*		*		*
CO4	*	*		*				*		*		*
CO5	*	*		*				*		*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title: DC MACHINES & SYNCHRONOUS MACHINES LAB.		
Course Code : EEL66	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:
1. To introduce various testing methods for DC and synchronous machines.
2. To learn various losses occurring in DC machines and to find efficiency of a DC machines.
3. To learn the characteristics, performance and speed control of DC machines.
4. To determine voltage regulation of synchronous machines by various methods.
5. To study the behavior of synchronous machine connected to infinite bus bars.

Unit No.	Syllabus Content
1	Open circuit characteristics of DC machine.
2	Load characteristics of a D.C. shunt and compound generator - i) short shunt-cumulative and differential (ii) Long shunt-cumulative and differential.
3	Load test on a DC motor - determination of speed-torque and HP-efficiency characteristics.
4	Swinburne's test.
5	Hopkinson's test.
6	Speed control of DC motor by armature voltage control and flux control.
7	Ward Leonard method of speed control of D.C. motor.
8	Voltage regulation of an alternator by EMF and MMF method.
9	Voltage regulation of an alternator by ZPF method.
10	Slip test and determination of regulation.
11	Performance of synchronous generator connected to infinite bus under constant power and variable excitation.
12	V and Inverted V curves of a synchronous motor.
13	Field's test on series motors.*
14	Load test on series generator.*
	* - Experiments beyond syllabus

Course Outcome: At the end of the course students will be able to -
CO1: choose proper testing method to determine losses and efficiency of a DC machine and to determine voltage regulation of synchronous generator.
CO2: explain the characteristics of DC machines and synchronous machines by conducting suitable tests.
CO3: apply the basic concept for experimental determination of voltage regulation of synchronous generator.
CO4: analyze the performance of DC machines on load and synchronous machines on infinite bus bars.
CO5: evaluate the losses and efficiency of DC machines and performance of synchronous machines connected to infinite bus bars.

REFERENCES:

1. Laboratory Manual

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*							*	*		*
CO2	*	*							*	*		*
CO3	*	*							*	*		*
CO4	*	*							*	*		*
CO5	*	*							*	*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : DIGITAL SIGNAL PROCESSING LAB		
Course Code : EEL67	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

Unit No.	Syllabus Content
1	Direct Computation of N-point DFT.
2	IIR filter realization using cascade form and Parallel form.
3	IIR Filter Design using Butterworth method.
4	IIR Filter Design using Chebyshev type 1 prototype.
5	IIR Filter Design using rectangular, hamming, window.
6	FIR Filter Design using Hanning, Blackman window.
7	N-Point Circular Convolution and Proof in frequency domain.
8	Circular Convolution, Linear Convolution and Linear Convolution using Circular Convolution.
9	Sampling Theorem.
10	Impulse response from X[n] and y[n].
11	Impulse response from difference equation and response to x[n].
12	N-point DFT using decimation in Time and Frequency FFT.*
13	N-point IDFT using decimation in Time and Frequency FFT.*
	* - Experiments beyond syllabus

Course Outcome At the end of the course students will be able to -
CO1: Write & execute the program to find DFT, Circular Convolution & Linear convolution.
CO2: Write & execute program to find Impulse response of LTI system.
CO3: Differentiate & Write program for FIR & IIR Filter Structures.
CO4: Design & Write program for IIR filters.
CO5: Design & Write program for FIR filters.

REFERENCES:

1. Proakis, Digital Signal Processing Principle, Algorithm & application. Pearson, 4th edition, 2009.
2. Sanjeet. K. Mitra, Digital Signal Processing. TMH, 3rd edition, 2009.
3. Laboratory Manual

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*			*			*		*		*
CO2	*	*		*	*			*		*		*
CO3	*	*			*			*		*		*
CO4	*	*		*	*			*		*		*
CO5	*	*		*	*			*		*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : ELECTRICAL POWER UTILIZATION		
Course Code : EE641	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:
1. To learn electrical energy utilization in industrial and domestic applications.
2. Introduce to the students the applications of electric and hybrid machines in traction system.

Unit No.	Syllabus Content	No. of Hours
1	**Electric heating:** Advantages and methods of electric heating, resistance ovens, induction heating, dielectric heating, the arc furnace.	08
2	**a) Electric welding:** Resistance and arc welding, control devices and welding equipment. **b) Electrolytic process:** Fundamental principles, extraction, refining of metals and electroplating. Factors affecting electro deposition process, power supply for electrolytic process.	07
3	**Illumination:** Laws of illumination, lighting calculation, factory lighting, flood lighting, street lighting, different types of lamps-incandescent, fluorescent, vapor, cfl and led lamps and their working, comparison, glare and its remedy.	07
4	**Electric traction:** Introduction, requirements of an ideal traction, systems of traction, speed time curve, tractive effort, co-efficient of adhesion, specific energy, factors affecting specific energy consumption. Selection of traction motors, method of speed control, energy saving by series parallel control, electric braking.	09
5	**a) Ac traction:** AC traction equipment, diesel electric equipment. Ac series motor – characteristics, linear induction motor and their use, trains lighting system. **b) Introduction to electric and hybrid vehicles:** Configuration and performance of electrical vehicles, traction motor characteristics, tractive effort, transmission requirement, vehicle performance and energy consumption.	08

Course Outcome: At the end of the course students will be able to -
CO1: Classify and explain - electric heating methods and furnaces, compare different heating methods. (L1 and L2)
CO2: Apply the basic concepts of electrical engineering in utilization of electrical power for industry and domestic applications. (L3)
CO3: Analyze systems of electric traction, motors for traction and their control. (L4)
CO4: Evaluate systems of traction and traction equipment, construct block diagram for electric and hybrid vehicles. (L5)
CO5: Design lighting schemes for industrial and domestic applications. (L6)

TEXT BOOKS:
1. Utilization of Electric Energy. E Openshaw Taylor, 12th Impression, 2009, Universities Press.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles. Mehrdad, Ehsani, Yimin Gao, Sabastien. E. Gay, Ali Emadi- CRC Press.

REFERENCE BOOK/WEBSITE LINKS:
1. A Course in Electrical Power. Soni Gupta and Bhatnager-Dhanapat Rai & sons.
2. Electrical Power. Dr. S.L.Uppal, Khanna Publications.

INSTRUCTIONS TO PAPER SETTERS
1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*								*
CO2	*	*	*	*								*
CO3	*	*	*	*								*
CO4	*	*	*	*								*
CO5	*	*	*	*								*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : ELECTRICAL DESIGN, ESTIMATION AND COSTING		
Course Code : EE642	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. Calculation or computation of all required engineering materials and expenditure likely to be incurred in carrying out a given work before execution, residential building electrification, General rules guidelines for wiring of residential installation and positioning of equipments, and earthing procedures.
2. To understand various types of service connections, inspection and testing of wiring installations, electrical installation for power circuits, design and estimation of overhead Transmission and Distribution lines.

Unit No.	Syllabus Content	No. of Hours
1	**GENERAL PRINCIPLES OF ESTIMATION:** Introduction to estimation & costing, electrical schedule, catalogues, market survey and source selection, recording of estimates, determination of required quantity of material, labor conditions, determination of cost material and labour, contingencies, overhead charges, profit, purchase system, purchase enquiry and selection of appropriate purchase mode, comparative statement, purchase orders, payment of bills, tender form, general idea about i.e. rule, Indian electricity act and major applicable I.E rules.	**07**
2	**RESIDENTIAL BUILDING ELECTRIFICATION:** General rules guidelines for wiring of residential installation and positioning of equipments, principles of circuit design in lighting and power circuits, procedures for designing the circuits and deciding the number of circuits, method of drawing single line diagram, selection of type of wiring and rating of wires and cables, load calculations and selection of size of conductor, selection of rating of main switch, distribution board, protective switchgear ELCB and MCB and wiring accessories, earthing of residential installation, sequence to be followed for preparing estimate, preparation of detailed estimates and costing of residential installation.	**07**
3	**SERVICE CONNECTION, INSPECTION AND TESTING OF INSTALLATION:** Concept of service connection, types of service connection and their features, method of installation of service connection, estimates of under - ground and overhead service connections, inspection of internal wiring installations, inspection of new installations, testing of installations, testing of wiring installations.	**08**
4	**ELECTRICAL INSTALLATION FOR POWER CIRCUITS:** Introduction, important considerations regarding motor installation wiring, determination of input power, determination of input current to motors, determination of rating of cables, determination of rating of fuse, determination of size of conduit, distribution board main switch and starter**.**, reason for excess recording of energy consumption by energy meter.	**08**
5	**DESIGN AND ESTIMATION OF OVERHEAD TRANSMISSION & DISTRIBUTION LINES:** Introduction, typical ac electrical power system, main components of overhead lines, line supports, factors	**09**

	governing height of pole, conductor materials, determination of size of conductor for overhead transmission line, cross arms, pole brackets and clamps, guys and stays, conductors configuration spacing and clearances, span lengths, overhead line insulators, insulator materials, types of insulators, lightning arrestors, phase plates, danger plates, anti climbing devices, bird guards, beads of jumpers, muffs, points to be considered at the time of erection of overhead lines, erection of supports, setting of stays, fixing of cross arms, fixing of insulators, conductor erection, repairing and jointing of conductor , dead end clamps, positioning of conductors and attachment to insulators, jumpers, tee-offs, earthing of transmission lines, guarding of overhead lines, clearances of conductor from ground, spacing between conductors, testing and commissioning of overhead distribution lines, some important specifications.	

Course Outcome: At the end of the course students will be able to -

CO1: apply the knowledge of electrical engineering drawing, IE rules, NEC, different types of electrical installation, their design considerations and equipments.

CO2: Design and prepare working drawing of different Installation projects.

CO3: Understanding of the methods and procedure of estimating the material required.

CO4: Enables the student to develop the skill of preparing schedule of material.

CO5:To prepare detailed estimates; costing of different types of Installation which leads to preparing of the tender documents, procedure for tendering, evaluation and billing of executed work of different types of electrical Installation Project.

TEXT BOOKS:

1. Electrical Installation Estimating & Costing**,** J.B.Gupta, VIII Edition S.K. Katria& Sons New Delhi.

REFERENCE BOOK/WEBSITE LINKS:

1. Electrical Design Estimating and Costing,K.B.RainaS.K.Bhattacharya, New Age International
2. Electrical Wiring Estimating and Costing,Uppal, Khanna Publishers Delhi

I.E. Rules and Act Manuals

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*						*	*	*
CO2	*	*		*						*	*	*
CO3	*	*		*						*	*	*
CO4	*	*		*						*	*	*
CO5	*	*		*	*	*		*	*	*	*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : PROGRAMMABLE LOGIC CONTROLLERS		
Course Code : EE643	No. of Credits:4; L:T:P - 3:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. The need of automation in the industry with basic controller mechanisms involved.
2. The programming concepts to achieve the desired goal or to define the various steps involved in the automation and the programming languages involved with basic subroutine functions.
3. To make use of the internal hardware circuits of automation circuit to control the devices during various states with monitoring the timers and counters.
4. To handle the data of the I/O devices to interface the data with the controller and auxiliary devices.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction:** Introduction to programmable logic controller (plc), role in automation (scada), advantages and disadvantages, hardware, internal architecture, sourcing and sinking, characteristics of I/O devices, list of input and output devices, examples of applications. I/O processing, input/output units, signal conditioning, remote connections, networks, processing inputs i/o addresses.	11
2	**Programming:** Ladder programming- ladder diagrams, logic functions, latching, multiple outputs, entering programs, functional blocks, program examples like location of stop and emergency switches.	10
3	**Programming Languages:** Instruction list, sequential functions charts & structured text, jump and call subroutines.	10
4	**Internal Relays:** Ladder programs, battery- backed relays, and one - shot operation, set and reset, master control relay. **Timers and Counters**: Types of timers, programming timers, on and off- delay timers, pulse timers, forms of counter, programming, up and down counters, timers with counters, sequencer.	11
5	**Shift Register And Data Handling**: Shift registers, ladder programs, registers and bits, data handling, arithmetic functions, temperature control and bottle packing applications.	10

Course Outcome: At the end of the course students will be able to -

CO1: Need of automation and its various control strategies with its auxiliary devices.

CO2:Programs for various functional block consisting of multiple inputs and outputs and to control

CO3:Programming issues with subroutines and debugged

CO4: The use of auxiliary units of a controller with hardware exposure.

CO5: The data handling with simple hardware.

TEXT BOOKS:

1. Programmable Logic controllers**.** W Bolton, 5th edition, Elsevier- newness, 2009.
2. Programmable logic controllers **-** principles and applications. John W Webb, Ronald A Reis, Pearson Education, 5th edition, 2nd impression, 2007.

REFERENCE BOOK/WEBSITE LINKS:

1. Programmable Controller Theory and Applications, L.A.Bryan, E. A Bryan, An industrial text company publication, 2nd edition, 1997.
2. Programmable Controllers, An Engineers Guide. E. A Paar, newness, 3rd edition, 2003.https://onlinecourses.nptel.ac.in

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*								
CO2	*		*	*							*	
CO3			*	*	*							
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : POWER SYSTEM PLANNING		
Course Code : EE651	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective: To learn

1. Structure of power system, grid system, Load fore casting and modeling.
2. Integrated and co-generation, power pooling trading, financial planning and tariffs.
3. Computer aided planning, greenhouse effect, insulation coordination and reactive power compensation.
4. Reliability of power supply, load prediction, power system expansion and management.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction of Power Planning**: National and regional planning, structure of power system, planning tools, electricity regulation, Load forecasting, forecasting techniques, modeling.	07
2	**Generation Planning**: Integrated power generation, co-generation / captive power, power pooling and power trading, transmission & distribution planning, power system economics, power sector finance, financial planning, private participation, rural electrification investment, concept of rational tariffs.	08
3	**Computer Aided Planning:** Wheeling, environmental effects, green house effect, technological impacts, insulation co-ordination, reactive compensation.	07
4	**Power Supply Reliability**: Reliability planning, system operation planning, load management, load prediction, reactive power balance, online power flow studies, test estimation, computerized management. Power system simulator.	08
5	**Optimal Power System Expansion Planning**: Formulation of least cost optimization problem incorporating the capital, operating and maintenance cost of candidate plants of different types (thermal, hydro, nuclear, non conventional).	09

Course Outcome: At the end of the course students will be able to –

CO1: How to the plan the structure of power system and to model it, outline of grid in India

CO2:Explain finance, tariff, private sector participation and rural electrification.

CO3:Analyze the environmental effects, green house effect, technological impacts, insulation co-ordination, in power system planning.

CO4:Determine the reliability of planning, load management, load reactive power balance.

CO5:Formulate the least cost optimization problem, operating and maintenance cost of candidate plants.

TEXT BOOKS:

1. A.S.Pabla, Electrical Power System Planning. Macmillan India Ltd, 1998

REFERENCE BOOK/WEBSITE LINKS:

1. S.S. Murthy, **Power System Planning and Control**

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*		*	*	*			
CO2	*	*			*			*	*		*	*
CO3	*	*	*		*		*	*	*			
CO4	*	*			*			*	*		*	*
CO5	*	*	*		*			*	*		*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : SPECIAL MACHINES		
Course Code : EE652	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:
1. Understand the concepts of Special electrical machines.
2. Analyze the necessity of sensors used in Special electrical machines.
3. Explain the characteristics and different speed - torque control schemes.
4. Model the electrical machines with voltage, current, torque and speed equations.

Unit No.	Syllabus Content	No. of Hours
1	**Stepper Motor:** Types of motors, working, windings, torque, characteristic, open and closed loop control, and microprocessor/microcontroller based control of motors, comparison of stepper motors, applications.	08
2	**Switched Reluctance Motor (SRM):** Construction, working, basics of SRM, pole arc and tooth arc, torque equation, characteristics, power converter circuits, current regulators, sensors, microprocessor/microcontroller based control of SRmotor and applications.	08
3	**Brushless Permanent Magnet DC (BLDC) Motor:** Classification of BLDC motors, construction, working, commutation, principle of operation, square wave generator, types of motors, and microprocessor/microcontroller/DSP based control of motors, Necessity of Hall sensors and optical sensors, comparison of brushed and brushless dc motors, applications.	10
4	**Permanent Magnet Synchronous Motor (PMSM):** Construction, principle of operation, emf equation, torque equation, comparison of conventional and PMSM motors, control and applications.	06
5	**Linear Induction Motor and Axial Flux Machines**: Construction, types, Principle of operation, and applications.	07

Course Outcome: At the end of the course students will be able to -
CO1: Understand the construction and operation of different special electrical machines.
CO2: Compare merits, demerits of different special electrical machines and their applications.
CO3: Explain the control and performance parameters of special electrical machines.
CO4: Develop torque equation and analyze speed –torque characteristics of special electrical machines.
CO5: Analyze different power converter topologies for operation of special electrical machines.
CO6: Apply digital control techniques for the operation and control of special electrical machines.

TEXT BOOKS:

1. E.G. Janardhanan,Special Electrical Machines, PHI, 2014.
2. K. Venkataratnam, Special Electrical Machines, University Press, Reprint, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. Miller, T.J.E.“Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, Oxford, 1989.
2. Kenjo, T, “Stepping Motors and their Microprocessor control”, Clarendon Press, Oxford, 1989.
3. Naser A and Boldea I, “Linear Electric Motors: Theory, Design and Practical Application”, Prentice Hall Inc., New Jersey,1987
4. R.Krishnan, Switched Reluctance motor drives-Modeling, Simulation, Analysis, Design, and Applications, CRC Press, 2015.

https://onlinecourses.nptel.ac.in/

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1		*										
CO2			*									
CO3			*									
CO4				*			*					
CO5					*		*					*
CO6									*	*	*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : REACTIVE POWER MANAGEMENT		
Course Code : EE653	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:
1. Importance of Reactive Power, in a power system and Harmonics and Compensation methods.
2. Reactive power control in Transmission schemes. Discussion on effects of Transmission line length, Load power and power factor on Reactive power.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction**: Importance of reactive power control in EPS, Reactive power devices. Theory of Load Compensation: Introduction- Requirement for compensation, Objectives in load compensation, Specifications of a load compensator, Power factor correction and voltage regulations in single phase system, Phase balancing and PF correction of unsymmetrical loads, Compensation in term of symmetrical components.	8
2	**Reactive Power Control**: Fundamental requirement in AC Power transmission, Fundamental transmission line equation, Surge impedance and natural loading, Voltage and current profiles of uncompensated radial and symmetrical line on open circuit, Uncompensated line under load, Effect of line length, Load power and PF on voltage and reactive power.	8
3	**Passive and Active compensators**: Uniformly distributed fixed compensation, Passive shunt compensation, Control of open circuit voltage by shunt reactance, Reactance of shunt reactors, multiple shunt reactors along the line.	7
4	**a) Series Compensation**: Objectives and practical limitations, Symmetrical line with mid-point series capacitor and shunt reactor, Power transfer characteristics and maximum transmissible power for a general case, Fundamental concepts of compensation by sectioning. **b) Principles of Static Compensation**: Principle of operation of thyristor controlled reactor, Thyristors switched capacitor. Series Capacitors: Introduction, protective gear, reinsertion schemes, Varistor protective gear.	8
5	**a) Synchronous Condenser**: Introduction, Power system Voltage control, Emergency reactive power supply, Starting methods, starting motor, reduced voltage starting, static starting. **b) Harmonic effects**: Resonance, Shunt Capacitors and Filters, telephone interferences, Reactive Power Co-ordination, Reactive power management, transmission benefits, and reactive power dispatch & equipment impact.	8

Course Outcome: At the end of the course students will be able to -

CO1: Able to understand how Reactive power supply is essential for reliably operating the electric transmission system.

CO2: Able to Understand the effects of inadequate reactive power (voltage collapses and major power outages).

CO3: Undertstand passive and active compensators.

CO4: Able to Have the knowledge of various methods of load and line Compensations.

CO5: Able to Understand theory and applications of synchronous condensers, various effects of harmonics and Reactive power management.

TEXT BOOKS:

1. Reactive power control in electric power systems. T. J. E. Miller, BSP books Pvt Ltd, 2011.
2. Reactive Power Management. D. Tagare, TMH, 1^{st} Edition, 2004.

REFERENCE BOOK/WEBSITE LINKS:

1. Power System Stability and Control. P. Kundur, TMH, 9^{th} reprint, 2007.
2. Power System Voltage Stability. Carson. W. Taylor, McGraw-Hill, Inc.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*			*			*	*	*
CO2		*	*	*	*		*			*		
CO3		*	*		*						*	*
CO4	*	*	*						*	*	*	*
CO5			*	*			*			*	*	*

DR. AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : COMPUTER TECHNIQUES IN POWER SYSTEMS ANALYSIS		
Course Code : EE71	No. of Credits:4; L:T:P - 3:2:0	No. of hours/week: 3+2
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 65

Course Objective: Students will be able to

1 Understand Network Topology, Network matrices to formulate Ybus and Zbus

2 Perform Load flow analysis using different numerical techniques.

3 Perform economic operation on power system.

4 Evaluate transient stability analysis of power system.

Unit No.	Syllabus Content	No. of Hours
1	**Network Matrices:** Introduction, elementary graph theory – oriented graph, tree, co-tree, cut set, loop. Incidence matrices: element-node, bus, basic cut set, basic loop. Primitive network – impedance form and admittance form. Formation of Y_{BUS} by method of inspection (including transformer off-nominal tap setting) and by method of singular transformation ($Y_{BUS} = A^TyA$). Formation of bus impedance matrix by step by step building algorithm (without mutual coupling elements).	8+6
2	**Load Flow Studies 1:** Introduction, power flow equations, classification of buses, operating constraints, data for load flow, Gauss-Seidal method – formulation of voltage equation. Algorithm and flow chart for PQ and PV buses (numerical problems for one iteration only).	8+5
3	**Load Flow Studies 2:** Newton-Raphson's method – formulation of power residue equations, evaluation of Jacobian elements. Algorithm and flow chart in polar coordinates (numerical problems for one iteration only). Fast decoupled load flow. Comparison of load flow methods.	9+5
4	**Economic Operation Of Power System:** Introduction, performance curves, economic generation scheduling neglecting losses and generator limits. Economic generation scheduling including generator limits and neglecting losses, iterative techniques. Economic dispatch including transmission losses – approximate penalty factor, iterative technique for solution of economic dispatch with losses. Derivation of transmission loss formula.	8+6
5	**Transient Stability Studies:** Introduction to transient stability. Numerical solution of swing equation – point-by-point method, modified Euler's method, Milne's Method, Runge-Kutta method.	6+4

Course Outcome: At the end of the course students will be able to -

CO1: Recall and relate the graph theory to Power System, define fundamental matrices and form Ybus and Zbus matrices

CO2: Classify the buses and formulate the power flow problems of power system network.

CO3: Solve the power flow problems through different iterative techniques.

CO4: Analyze the economic operation of power system under various operating conditions.

CO5: Evaluate the transient stability of the power system through different numerical methods.

TEXT BOOKS:

1. Stag G. W. and EI-Abiad A. H., **Computer Methods in Power System Analysis,** McGraw Hill International Student Edition. 1968
2. Uma Rao, Computer Techniques in Power System, IK International Publishing House pvt. Ltd., Bangalore

REFERENCE BOOK/WEBSITE LINKS:

1. Haadi Sadat**, Power System Analysis,** TMH, 2nd Edition, 12th reprint, 2007
2. Pai M. A, **Computer Techniques in Power System Analysis**, TMH, 2nd edition, 2006.
3. Singh L.P **Advanced Power System Analysis and Dynamics**, New Age International (P) Ltd, New Delhi, 2001.
4. Dhar R.N, **Computer Aided Power System Operations and Analysis**"- TMH, 1984.
5. Nagrath I. J., and Kothari D. P, **Modern Power System Analysis,** TMH, 3rd Edition, 2003.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*				*			*		*
CO2	*	*		*	*			*				*
CO3	*	*		*	*					*		*
CO4	*	*		*	*					*		*
CO5	*	*	*	*		*				*		

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : HIGH VOLTAGE ENGINEERING		
Course Code : EE72	No. of Credits: 4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective: To impart the students
1. The basics of High voltage Engg and to learn Break down mechanisms of insulating media
2. The concepts on generation of High AC. DC and impulse voltages and currents.
3. To learn technique of measurement of High AC, DC and impulse voltages and currents.
4. To understand the testing of high voltage equipments.

Unit No.	Syllabus Content	No. of Hours
1	**a) Introduction:** Introduction to HV technology, role of insulation in electrical apparatus, need for generating high voltages in laboratory. Industrial applications of high voltage. **b) Breakdown phenomena:** Classification of HV insulating media. Properties of important HV insulating media under each category. **c) Gaseous dielectrics**: Ionization: primary and secondary ionization processes. Criteria for gaseous insulation breakdown based on Townsend's theory. Limitations of Townsend's theory. Streamer's theory of breakdown in non-uniform fields. Corona discharges. Breakdown in electro negative gases. Paschen's law and its significance. Time lags of breakdown. **d) Solid dielectrics**: Breakdown in solid dielectrics: intrinsic breakdown, avalanche breakdown, thermal breakdown, and electro mechanical breakdown. **e) Liquid dielectrics**: Breakdown of liquid dielectrics: Suspended particle Theory, Cavity breakdown (Bubble's theory), and Stressed Oil Volume theory.	12
	a) Generation of HVAC voltages: HVAC-HV transformer; need for cascade connection and working of transformers units connected in cascade. Series resonant circuit- principle of operation and advantages. Tesla coil. **b) Generation of HVDC voltages:** Half and full wave rectifier circuits**,** voltage doubler circuit, Cockroft-walton type high voltage generator set. Calculation of voltage regulation, ripple and optimum number of stages for minimum voltage drop. Electrostatic generators - Van–de-graff generator.	10
3	**Generation of impulse voltage and current:** Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator-expression for output impulse voltage. Multistage impulse generator, working of modified Marx multi stage impulse generator circuit. Rating of impulse generator. Components of multistage impulse generator. Triggering of impulse generator by three electrode gap arrangement. Trigatron gap and oscillograph time sweep circuits. Generation of switching impulse voltage. Generation of high impulse current.	10
4	**Measurement of high voltages:** Electrostatic voltmeter-principle, construction and limitation. Chubb and fortescue method for HVAC measurement. Generating voltmeter- principle, construction. Series resistance micro ammeter for HVDC measurements. Standard sphere gap- measurement of HVAC, HVDC, and	10

	impulse voltages; factors affecting the measurements. Potential dividers-Resistance dividers, Capacitance dividers and mixed RC potential dividers. Measurement of high impulse currents- Magnetic links.	
5	**a) Non-destructive insulation testing techniques:** dielectric loss and loss angle measurements using Schering bridge, transformer ratio arm bridge. Need for discharge detection and pd measurements aspects. Factor affecting the discharge detection. Discharge detection methods-straight and balanced methods. **b) High voltage tests on electrical apparatus**: Definitions of terminologies, tests on Isolators, Circuit Breakers, Cables, Insulators, Bushings and Transformers.	10

Course Outcome: At the end of the course students will be able to -
CO1: Explain the need for high voltages and currents\.
CO2: Explain the physics of break down mechanisms of insulating media.
CO3: Compare the merits and demerits of generation of high voltage and currents.
CO4: Select suitable method for measurement of high voltages and currents.
CO5: Explain the method of conducting the high voltage tests on different electrical equipments.

TEXT BOOKS:
1. M.S.Naidu and Kamaraju, High Voltage Engineering, - 4th Edition, TMH, 2008.
2. E.Kuffel and W.S. Zaengl, High Voltage Engineering Fundamentals, 2nd Edition, Elsevier Press,2005.

REFERENCE BOOK/WEBSITE LINKS:
1. R.S. Jha, High Voltage Engineering, DhanpatRai& Sons, New Delhi, 1984.
2. Mazen Abdel-Salam, Hussein Anis, Ahdab El- Morshedy, RoshdyRadwan, High Voltage Engineering Theory and Practice, 2nd Edition (Revised & Expanded) Marcel-Dekker Publishers (Special Indian edition.).

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*											*
CO2	*						*					*
CO3		*					*					*
CO4		*		*								*
CO5			*									*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIISEMESTER		
Course Title : RELAY AND HIGH VOLTAGE LABORATORY		
Course Code : EEL74	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

1. To study the characteristics of various protection devices.
2. To study the flashover characteristics of air insulation subjected to HVAC and HVDC under uniform and non-uniform field configuration.
3. To study the field distribution in the conductor dielectric medium.
4. To study the generation of standard lightning impulse voltage wave and to evaluate the front and tail times.

Unit No.	Syllabus Content
1	Operating characteristics of non-directional over-current (electro-mechanical) relay.
2	IDMT characteristics of over voltage or under voltage relay.(solid state or electromechanical type)
3	a) To determine 50% probability flashover voltage for air insulation subjected to impulse voltage. (b) Generation of standard lightning impulse voltage and to determine efficiency and energy of impulse generator.
4	Operating characteristics of over voltage or under voltage relay. (Solid state or electromechanical type).
5	Current-time characteristics of fuse.
6	Operating characteristics of microprocessor based (numeric) over –current relay.
7	Operating characteristics of microprocessor based (numeric) over/under voltage relay.
8	Motor protection scheme-fault studies.
9	Spark over characteristics of air insulation subjected to high voltage AC, with spark over voltage corrected to STP for uniform and non-uniform field configuration.
10	Spark over characteristics of air insulation subjected to high voltage DC for uniform & non-uniform field configurations with spark-over voltage corrected to STP.
11	Measurement of HVAC and HVDC using standard spheres.
12	Breakdown strength of transformer oil using oil-testing unit.
13	Field mapping using electrolytic tank for any one-model cable/capacitor/transmission line/ Sphere gap models.
14	Demonstration of cascade connection of transformers*
15	Measurement of partial discharges in underground cables*
	*- experiments beyond syllabus.

Course Outcome: At the end of the course students will be able to -
CO1: Identify the characteristics of protection devices for applications in power system protection[L2,CO1,PO1]
CO2: Distinguish between the flashover characteristics of air insulation subjected to HVAC under uniform and non- uniform field configuration[L4,CO2,PO3]
CO2: Distinguish between the flashover characteristics of air insulation subjected to HVDC under uniform and non- uniform field configuration[L4,CO2,PO3]
CO3: Illustrate the generation of standard lightning impulse voltage wave and to evaluate front and tail times.
CO4: Asses the field strength in liquid insulation and field distribution in the dielectric medium through field plotting.

REFERENCES:
1. Department Lab Manual.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*											*
CO2		*	*									*
CO3		*	*									*
CO4		*	*									*
CO5				*			*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIISEMESTER		
Course Title : POWER SYSTEM SIMULATION LABORATORY		
Course Code : EEL75	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

1. Acquire skills of using computer packages like MATLAB (coding and SIMULINK) in Power system studies.
2. Acquire skills of using MiPower package for designing and analysis of electrical power networks and investigate typical case study problems.

Unit No.	Syllabus Content
1	Using MATLAB, (i) Y-bus formation for power system without mutual coupling by singular transformation & (ii) inspection method.
2	Determination of bus currents, bus power and line flows for a specified system voltage (bus) profile.
3	Using MATLAB-Determination of power angle diagrams for (i) salient and (ii) non-salient pole synchronous machines, reluctance power, excitation emf and regulation
4	Using Mi-Power, to determine fault currents and voltages in a single transmission line system with star-delta transformers at a specified location for (i) SLGF, (ii) DLGF and (iii) LLF.
5	Using MATLAB-To determine i) Swing curve ii) critical clearing time for a single m/c connected to infinite bus through a pair of identical transmission lines, for a 3-phase Fault on one of the lines for variation of inertia constant / line parameters / fault location / clearing time / pre fault electrical output.
6	Using Mi-power, Load flow analysis for (i) three bus (ii) five bus system using Gauss Seidal and Newton Raphson method.
7	Using MATLAB- Gauss Seidel method for Load flow Analysis for one iteration for the given power system.
8	Using Matlab, Formation of Jacobian for a system not exceeding four buses (no PV buses)
9	Using Mi-Power, Optimal generator scheduling for thermal power plants.
10	Using MATLAB, Optimal generator scheduling for thermal power plants
11	Using MATLAB- Load flow analysis by Newton Raphson method*
12	Y- bus formation for power system with mutual coupling by singular transformation method.*
	* - Experiments beyond syllabus

Course Outcome: At the end of the course students will be able to -
CO1: Experiment with software packages (Matlab and MiPower) to solve Power system parameters.
CO2: Develop programs and models using computer based tools for optimal generator scheduling.
CO3: Analyze different types of faults for stability studies.
CO4: Compute Load flow parameters using numerical methods.
CO5: Apply the knowledge to solve real time problems.

REFERENCES:
1. EEE Department Lab Manual,
2. PRDC Lab Manual

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*											*
CO2	*		*	*	*		*	*	*	*		
CO3	*	*	*	*			*		*			
CO4	*	*		*								*
CO5	*		*		*		*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMSTER		
Course Title : COMPUTER AIDED ELECTRICAL DRAWING		
Course Code : EEL76	No. of Credits:3; L:T:P - 0:2:2	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50+ 50 = 100 Marks	

Course Objective: In this course students will learn

1. The various kinds of armature winding used in electrical machines and the arrangement of the entire winding
2. Assembly drawing showing, how the different parts fit together and provide sufficient information to enable the assembly of a component.
3. Sectional views showing how parts fit and expose hidden details, clearly in the simplest and shortest way.
4. The computer drafting skill to express ideas on a paper through the medium of drawing.

Unit No.	Syllabus Content
1	Single layer Lap and Wave windings
2	Double layer Simplex Lap and Wave windings
3	Double layer duplex Lap and Wave windings
4	Equalizers and dummy coils
5	Integral and Fractional slot double layer Lap windings, short pitch ac windings
6	Integral and Fractional slot double layer Wave windings, short pitch ac windings
7	Hemitropic Un-bifurcated 2 and 3 tier windings, Bifurcated 2 and 3 tier windings, mush type windings.
8	Transformers sectional views of a limb and core type single phase and three transformers
9	Single phase Shell type transformers sectional views
10	Synchronous Machines: Sectional views of Rotor and stator.
	Beyond the Syllabus
1	D.C. machine: sectional views of a pole, yoke & field assembly, armature and commutators dealt separately
2	Sectional views stator and rotor of Induction Machine

Course Outcome: At the end of the course students will be able to -
CO1. Recognize the various types armature winding patterns of rotating dc_ machines
CO2. Draw the diagrams armature winding patterns of rotating ac_ machines.
CO3. Develop the winding patterns suitable for the ratings of the machines
CO4. Assemble the various parts and draw their sectional views from given data
CO5. Analyze and draw the sectional assembled views of various machines from the given data

REFERENCE;

1. M. G. Say, Performance & Design of Alternating Current machines. CBS publishers, 3rd Edition, 2002.
2. A.E Clayton & N.N.Hancock, The Performance & Design of DC machines. CBS Publication, 3rd Edition, 2004.
3. A K Sawhney, Electrical Machine Design. Khanna Publishers.
4. SF Devalapur, Electrical Drafting, EBPB Publication, 8th Edition, 2010
5. KL Narang, Electrical Engineering Drawing, Tech India Publications, 3rd Edition, 1986.
6. Dr. Indrani MS, Shankarlal VD & Beaula D, CAD for Electrical Engineers, Singuine Technical Publishers, Bengaluru, 2nd Edition, 2015
7. Auto CAD Manuals

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*			*					*		*	
CO2	*			*					*		*	
CO3	*			*					*		*	
CO4	*			*					*		*	
CO5	*			*					*		*	

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : FLEXIBLE A.C. TRANSMISSION SYSTEMS (FACTS)		
Course Code : EE731	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. To understand the important parameters which play a vital role in power transmission.
2. To learn the concept of compensations required for a power system and the method of compensations implemented.

Unit No.	Syllabus Content	No. of Hours
1	**FACTS, Concepts And General System Configuration**: Power Transmission, interconnection, flow of power in ac system, power flow and dynamic stability consideration of a transmission interconnection, relative importance of controllable parameters, and basic types of facts controllers, shunt, series, combined shunt and series connected controllers.	**07**
2	**POWER SEMICONDUCTOR DEVICES**: Types of high power devices, principle of high power device characteristics and requirements, power device material, diode, MOSFET, MOS Turn Off Thyristor, Emitter Turn OFF Thyristor, Integrated Gate Commuted Thyristor (GCT & IGCT).	**07**
3	**a) VOLTAGE SOURCED CONVERTERS**: basic concepts, single-phase full wave bridge converter operation, a single-phase bridge converter and 3-phase full wave bridge converter for square wave harmonics. **b) SELF AND LINE COMMUTATED CURRENT SOURCE CONVERTER**: Basic concepts, 3 phase full wave rectifier, thyristor based converter, current sourced converters with turnoff devices, and current source converters versus voltage source converters.	**09**
4	**STATIC SHUNT COMPENSATORS SVC AND STATCOM**: Objective of shunt compensation, methods of controllable VAR generation, static VAR compensator, SVC And STATCOM, comparison between SVC And STATCOM.	**08**
5	**STATIC SERIES COMPENSATORS:** GCSC, TSSC, TCSC And SSSC, objectives of series compensation, variable impedance type of series compensation, switching converters, types, series compensation, external control for series reactive compensators.	**08**

Course Outcome: At the end of the course students will be able to -
CO1: Transmission network of a power system and its peripheral parameters of control
CO2: Brief Introduction of power devices and its characteristics to aid the control of power system parameter.
CO3: Different configuration of Converter systems.
CO4: The concept of shunt compensation and to implement in a power system
CO5: The concept of series compensation and to implement in a power system

TEXT BOOKS:

1.Understanding Facts - Concepts and technology of flexible AC Transmission system, N.G.Hungorian& Laszlo Gyugyi IEEE Press, standard publisher, 2001.

REFERENCE BOOK/WEBSITE LINKS:

1.EHV - AC, HVDC Transmission & Distribution Engineering,S.Rao, Khanna publishers, 3rd edition 2003.

2.FACTS - Controllers in Power Transmission distribution- K.R. Padiyar - New age publishers - 2007.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*			*						*
CO2	*	*								*		*
CO3	*	*	*	*	*		*			*		*
CO4	*	*	*	*	*		*			*		*
CO5	*	*	*	*	*		*			*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : ENERGY AUDITING & DEMAND SIDE MANAGEMENT		
Course Code : EE732	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1.To Understand basics of demand side management and mechanisms (technical, legal or financial) that influence energy consumption
2. To recognize opportunities for increasing rational use of energy and basics of energy auditing with application on different sectors.

Unit No.	Syllabus Content	No. of Hours
1	**INTRODUCTION**: Energy Situation – World And India, Energy Consumption, Conservation, Codes, Standards And Legislation.	07
2	**ENERGY ECONOMIC ANALYSIS:** The Time Value Of Money Concept, Developing Cash Flow Models, Payback Analysis, Depreciation, Taxes And Tax Credit – Numerical Problems.	07
3	**a) ENERGY AUDITING:** Introduction, Elements Of Energy Audits, Energy Use Profiles, Measurements In Energy Audits, Presentation Of Energy Audit Results. **b) ELECTRICAL SYSTEM OPTIMIZATION:** The Power Triangle, Motor Horsepower, Power Flow Concept.	09
4	**ELECTRICAL EQUIPMENT AND POWER FACTOR** – Correction & Location Of Capacitors, Energy Efficient Motors, Lighting Basics, Electrical Tariff, Concept Of ABT.	07
5	**DEMAND SIDE MANAGEMENT:** Introduction To DSM, Concept Of DSM, Benefits Of DSM, Different Techniques Of DSM – Time Of Day Pricing, Multi-Utility Power Exchange Model, Time Of Day Models For Planning, Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Management And Organization Of Energy Conservation Awareness Programs.	09

Course Outcome: At the end of the course students will be able to -
CO1: Understand the Energy situation in India and world Scenarios.
CO2: understand the Energy Economic analysis and develop cash flow models.
CO3: Study methods of energy accounting and energy auditing in energy sector, industry and final consumption. Finding opportunities to increase the rational use of energy.
CO4:Study of Electric Equipment and Power factor Correction methods
CO5: Familiarize with Demand side management, especially with management in energy sector engineering and Fundamentals of product strategy management.

TEXT BOOKS:

1. Industrial Energy Management Systems, Arry C. White, Philip S. Schmidt, David R. Brown, Hemisphere Publishing Corporation, New York.

3. Electrical Power distribution, A S. Pabla, TMH, 5th edition, 2004

REFERENCE BOOK/WEBSITE LINKS:

1. Recent Advances in Control and Management of Energy Systems, D.P.Sen, K.R.Padiyar, IndraneSen, M.A.Pai, Interline Publisher, Bangalore, 1993.

2. Energy Demand – Analysis, Management and Conservation, Ashok V. Desai, Wiley Eastern, 2005.

3. Demand Side Managementm, Jyothi Prakash, TMH Publishers.

4. Hand book on energy auditing - TERI (Tata Energy Research Institute)

5. Fundamentals of Energy Engineering - Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey.

6. Energy auditing and demand side management, Ajjanna, Gouthami publications,Shimaoga

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*			*	*			*		*
CO2	*	*	*			*	*			*		*
CO3	*	*	*			*	*			*		*
CO4	*	*	*			*	*			*		*
CO5	*	*	*			*	*			*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : POWER SYSTEM DYNAMICS AND STABILITY		
Course Code : EE733	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. **Introduction to** basic concepts of power system dynamics and stability. Review of classical methods, **system modeling, and dynamics of synchronous generator.**
2. Types of excitation and controllers, prime movers, SMIB, Transient stability evaluation and controllers.

Unit No.	Syllabus Content	No. of Hours
1	**a) Introduction:** basic concepts of power system dynamics and stability. Review of classical methods. **b)System modeling and dynamics of synchronous generator:** modeling of synchronous machine, swing equation, park's transformation – park's voltage equation, park's mechanical equation (torque). Applications – (a) voltage build up in synchronous machine, and (b) Symmetrical short circuit of generator.	12
2	**Excitation and prime mover controllers:** introduction, types of excitation, AVR with and without ESS, TGR, amplifier PSS, static exciters.	10
3	**Modeling of prime movers:** introduction, three major components, block diagram, hydraulic turbine, and steam turbine.	10
4	**Load modeling:** introduction, polynomial model and exponential model. Small signal angle stability: small signal angle stability with SMIB system, detailed model of SMIB.	11
5	**Transient stability analysis:** simulation for transient stability evaluation, transient stability controllers.	09

Course Outcome: At the end of the course students will be able to -

CO1: model and analyze the synchronous generator under dynamic condition.

CO2:analyse problems related to excitation system and prime mover controllers of synchronous generator

CO3: model and analyze electrical load for different stability studies.

CO4: apply simulation techniques for analysis of transient stability studies.

CO5: evaluate the condition of stability of power system using different methods

TEXT BOOKS:

1) Power System Dynamics, Stability and Control, Padiyar K.R., Interline Publications.
2) Power System Stability and Control, Prabha Kundur. TMH, 9th Reprint.

REFERENCE BOOK/WEBSITE LINKS:

1) Dynamics and Control of Large Electric Power Systems, Marija Ilic; John Zaborszky, , IEEE Press and John Wiley & Sons, Inc, 2007
2) Power System Control and Stability Revised Printing, Paul M. Anderson and A. A. Fouad, IEEE Press and John Wiley & Sons, Inc, 2002.
3) Selected topics from IEEE Transaction and Conference Proceedings
4) Computer Techniques in Power System, Uma Rao, IK International Publishing House pvt. Ltd., Bangalore

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*						*		
CO2	*	*		*						*		
CO3	*	*		*						*		
CO4	*	*		*	*							
CO5	*	*		*						*		

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMSTER		
Course Title : ELECTRICAL POWER QUALITY		
Course Code : EE734	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective: students learn

1. Use of power electronic components in power system, power quality problems and affects all connected electrical and electronic equipment,
2. Power quality problems of electrical machines and power systems.

Unit No.	Syllabus Content	No. of Hours
1	**a) Introduction**, power quality-voltage quality, power quality evaluation procedures term and definitions: general classes of power quality problems, transients, long duration voltage variation, short duration voltage variations, voltage imbalance, waveform distortion, power quality terms. **b) Voltage sags and interruptions:** sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, motor starting sags.	09
2	**Transient over voltages:** sources of transient over voltages, principles of over voltages protection, utility capacitor switching transients, fundamentals of harmonics: harmonic distortion, voltage versus transients, harmonic indexes, harmonic sources from commercial loads, harmonic sources from industrial loads, effects of harmonic distortion, intra-harmonics.	07
3	**Applied harmonics:** harmonic distortion evaluations, principles for controlling harmonics, harmonic studies, devices for controlling harmonic distortion, harmonic filters, standards of harmonics	07
4	**a) Power quality benchmark:** introduction, benchmark process, power quality contract, power quality state estimation, including power quality in distribution planning. **b)Distributed generation and quality**: DG technologies, interface to utility system, power quality issues, interconnection standards.	09
5	**Power quality monitoring:** monitoring considerations, power quality measurement equipments, assessment of power quality measurement data, application of intelligent systems, power quality monitoring standards.	07

Course Outcome: At the end of the course students will be able to -

CO1: Identify the causes and effects of power quality problems such as non-sinusoidal wave shapes, voltage outages, harmonic losses, origins of single-time events such as voltage dips, voltage reductions, and outages.

CO2: Adopt different techniques to mitigate the power quality problems.

CO3: Have a knowledge of guidelines and standards as well as industry regulations and practices for solving power quality problems in a cost-effective manner.

CO4: Have knowledge of estimating the power quality

CO5: Monitor the power quality using different techniques

TEXT BOOKS:

1.**Electric Power Quality,**Dugan, Roger C, Santoso, Surya, McGranaghan, Mark F/ Beaty, H. Wayne McGraw-Hill professional publication 2003.

REFERENCE BOOK/WEBSITE LINKS:

1. **Electric Power Quality,** G.T.Heydt, stars in a circle publications 1991**.**
2. **Modern Power Electronics,** M.H.Rashid TATA McGraw Hill 2002.
3. **Understanding power quality problems voltage sags and interruptions-** Math H. J. Bollen. IEEE Press, 2000
4. **Power quality in power systems and electrical machines, Ewald F Fuchs, Mohammad A.S., Masoum, academic Press, Elsevier, 2009.**

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*		*						*		
CO2	*	*		*						*		
CO3	*	*		*						*		
CO4	*	*		*						*		
CO5	*	*		*						*		

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : FUZZY LOGIC		
Course Code : EE735	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. Provide an emphasis on the differences and similarities between fuzzy sets and classical sets theories and understanding of the basic mathematical elements of fuzzy sets.
2. Emphasis on fuzzy logic inference with premise on fuzzy proposition
3. provide an introduction to fuzzy linear and non –linear controller design
4. Provide an insight into structure and design of adaptive controller.
5. Apply fuzzy inference in the area of process control and real time applications.

Unit No.	Syllabus Content	No. of Hours
1	**THE MATHEMATICS OF FUZZY CONTROL:** Fuzzy sets, properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, the extension principle.	07
2	**THEORY OF APPROXIMATE REASONING:** Linguistic variables, Fuzzy proportions, Fuzzy if- then statements, inference rules, compositional rule of inference.	07
3	**NON-LINEAR FUZZY CONTROL:** FKBC as a linear transient element, PID like FKBC, sliding mode FKBC, Sugeno FKBC.	07
4	**FUZZY KNOWLEDGE BASED CONTROLLERS (FKBC):** Basic concept structure of FKBC, choice of membership functions, scaling factors, rules, fuzzyfication and defuzzyfication procedures. Simple applications of FKBC (washing machines, traffic regulations, lift control, aircraft landing Control etc.).	09
5	**ADAPTIVE FUZZY CONTROL:** Process performance monitoring, adaption mechanisms, membership functions, tuning using gradient descent and performance criteria. Set organizing controller model based controller.	09

Course Outcome: At the end of the course students will be able to -
CO1: Be able to distinguish between the crisp set and fuzzy set concepts.
CO2: Be able to define fuzzy sets using linguistic variables and represent these sets by membership functions.
CO3: Become knowledgeable of conditional fuzzy propositions and fuzzy inference systems
CO4: Become aware of the use of fuzzy inference systems in the design of controllers.
CO5: Become aware of the application of fuzzy inference in the area of process control.

TEXT BOOKS:

1. Fuzzy Logic With Engineering Applications-TimotyRoss, John Wiley, Second Edition, 2009.
2. Fuzzy Sets Uncertainty and Information- G. J. Klir and T. A. Folger, PHI IEEE, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. An Introduction to Fuzzy Control, D. Diankar, H. Hellendoom and M. Reinfrank,Narosa Publishers India, 1996.
2. Essentials of Fuzzy Modeling and Control, R. R. Yaser and D. P. Filer, John Wiley, 2007.
3. Fuzzy Logic Intelligence Control And Information, Yen- Pearson education, First Edition, 2006

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*									
CO2	*	*	*	*								
CO3			*	*								
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 **ELECTRICAL AND ELECTRONICS ENGINEERING** **VII SEMESTER**		
Course Title : ARTIFICIAL NEURAL NETWORK		
Course Code : EE736	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To organize the structural components.
2. Computation methodology needed for information extraction and storage.
3. Perform computation through learning algorithms.
4. Optimization techniques.

Unit No.	Syllabus Content	No. of Hours
1	Introduction, history, structure and function of single neuron, neural net architectures, neural learning, use of neural networks. Supervised learning, single layer networks, perceptrons, linear separability, perception training algorithm, guarantees of success, modifications.	10
2	Multiclass networks-I, multilevel discrimination, back propagation, setting parameter values, theoretical results. Accelerating learning process, application, and Madaline adaptive multilayer networks.	12
3	Prediction networks, radial basis functions, polynomial networks, regularization, unsupervised learning, winner-take-all networks. Learning vector quantizing, counter propagation networks, adaptive resonance theorem, topologically organized networks, distance based learning, recognition.	12
4	Associative models, Hop Field networks, brain state networks, Boltzmann machines, hetero associations.	09
5	Optimization using Hopfield networks, simulated annealing, random search, evolutionary computation.	09

Course Outcome: At the end of the course students will be able to -

CO1: Need of neural networks and its various realizations.

CO2: Analysis of neural networks various functional blocks with multiple inputs and outputs information.

CO3: Programming issues with application of neural networks to single input single output system.

CO4: Application of neural networks to multi input multi output system.

CO5: Salient features of input data mining and Realization of Hybrid systems.

TEXT BOOKS:

1. Elements Of Artificial Neural Networks -KishanMehrotra, C. K. Mohan, Sanjay Ranka, Penram, 1997
2. Artificial Neural Networks- R, Schalkoff, McGraw Hill, 1997.

REFERENCE BOOK/WEBSITE LINKS:

1. Neural Network Design- Hagan, Demuth and Beale Cengage,2nd Edition
2. Introduction To Artificial Neural Systems- J. Zurada, Jaico, 2003
3. Neural Networks -Haykins, PHI, 1999.
4. Artificial Neural Networks, B.Yegnanarayana, PHI, 2009 Edition

https://onlinecourses.nptel.ac.in

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*									
CO2	*	*	*	*								
CO3			*	*								
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMESTER		
Course Title: ADVANCED CONTROL SYSTEM		
Course Code : EE737	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To study digital control system and mathematical modeling.
2. To study the stability analysis of linear and non-linear systems.

Unit No.	Syllabus Content	No. of Hours
1	**Digital Control Systems:** Review of difference equations and Z - transforms, Z- transfer function (Pulse transfer function), Z - Transforms analysis, sampled data systems, Stability analysis (Jury's Stability Test and Bilinear Transformation), Pulse transfer functions and different configurations for closed loop Discrete-time control systems.	12
2	**Modern Control Theory:** State model for continuous time and discrete time systems, Solutions of state equations (for both continuous and discrete systems).	10
3	Concepts of controllability and observability (For both continuous and discrete systems), Pole Placement by state feedback (for both continuous and discrete systems), Full order and reduced order observes (for both continuous and discrete systems).	10
4	Dead beat control by state feedback, Optimal control problems using state variable approach, State Regulator and output regulator, Concepts of Model reference control systems, Adaptive Control systems and design.	10
5	**Non Linear Control Systems**: Common nonlinearities, Singular Points, Stability of nonlinear systems – Phase plane analysis and describing function analysis, Lyapunov‟s stability criterion, Popov‟s criterion.	10

Course Outcome: At the end of the course students will be able to -

CO1: Understand the fundamentals of state variables, linear and nonlinear systems.
CO2: Analyze SISO and MIMO systems and obtain the state models.
CO3: Analyze and design concepts of model reference and adaptive control systems.
CO4: Perform analysis on Controllability and Observability.
CO5: Improve stability of a given system by state feedback pole placement techniques

TEXT BOOKS:

1. Digital control & state variable methods. M. Gopal , 3rd Edition, TMH ,2008
2. Control system Engineering. I. J. Nagarath & M. Gopal, New Age International (P) Ltd, 3rd edition.

REFERENCE BOOK/WEBSITE LINKS:

1) Modern Control Engineering, Ogata. K., PHI, 4th Edition.
2) Discrete time Control Systems, Ogata K, PHI, 2nd Edition.
3) Control Systems Engineering, Nagarath and Gopal, Wiley Eastern Ltd.
4) Modem Control System Theory, M Gopal, Wiley Eastern Ltd.
5) Digital Control & State Variable Methods, M. Gopal, TMH, 2006

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*								*		*
CO2	*	*				*				*		*
CO3	*	*				*				*		*
CO4	*	*				*				*		*
CO5	*	*				*				*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title: ADVANCED POWER ELECTRONICS		
Course Code : EE738	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. DC-DC circuit topologies analysis and operation.
2. Switching strategy and converter topologies for high frequency applications.
3. Design of high frequency magnetics.
4. Switching power supplies with electrical isolation for different power applications.

Unit No.	Syllabus Content	No. of Hours
1	**DC-DC SWITCHED MODE CONVERTERS:** Topologies, buck, boost, buck-boost, and cuk converters, full bridge DC-DC converter-detailed theory, working principles, modes of operation, with detailed circuits and wave forms, applications, merits and demerits	12
2	**DC-AC SWITCHED MODE INVERTERS:** Single-phase inverters, three phase inverters. SPWM inverter, detailed theory, working principles, modes of operation with circuit analysis, applications, merits and demerits, problems based on input output voltage relationship	11
3	**RESONANT CONVERTERS**: Zero voltage and zero current switching, resonant switch converters, and comparison with hard switching, switching locus diagrams, and working principle.	10
4	**HIGH FREQUENCY INDUCTOR AND TRANSFORMERS**: Design principles, definitions, comparison with conventional design and problems. Design of fly back transformer.	09
5	**POWER SUPPLIES**: Introduction, DC power supplies: fly back converter, forward converter, push-pull converter, half bridge converter, full bridge converter, AC power supplies: switched mode ac power supplies, resonant ac power supplies and bidirectional ac power supplies.	10

Course Outcome: At the end of the course students will be able to -
CO1: Name different power conversion topologies and it's with its auxiliary devices.
CO2: Discuss the various functional blocks with single inputs and multi outputs power supplies.
CO3: Evaluation of various control techniques
CO4: Analyze various components for high frequency applications.
CO5: Design power converters for various applications.

TEXT BOOKS:

1. **Power Electronics,** Daniel .W. Hart, TMH, First Edition, 2010.
2. **Power Electronics - converters, application & design**, Mohan N, Undeland T.M., Robins, W.P, John Wiley ,3^{rd} Edition 2008

REFERENCE BOOK/WEBSITE LINKS:

1. **Power Electronics-Circuits, Devices, Applications,** Rashid M.H., PHI, 3^{rd} Edition, 2008.
2. **Power Electronics Essentials and Applications**, L. Umanand, Wiley India Pvt Ltd,Reprint,2010
3. **Modern Power Electronics and A.C. Drives,** Bose B.K, PHI, 2009.
4. **Digital Power Electronics and Applications,** Muhammad Rashid, Elsevier, first edition, 2005.
5. **Power Electronics, Devices, Circuits and Industrial Applications** ,V.R.Moorthi,Oxford,7^{th} impression,2009
6. https://onlinecourses.nptel.ac.in

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*								
CO2	*		*	*							*	
CO3			*	*	*					*		
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: MODERN POWER SYSTEM PROTECTION		
Course Code : EE81	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 26+26

Course Objective:
1. To learn conventional and modern protection devices to protect power systems.
2. To introduce protection philosophy and embedded protection systems.
3. To study protection of power systems through Phasor Measurement technique.
4. To introduce different International Standards related to relaying.

Unit No.	Syllabus Content	No. of Hours
1	**a)Fuses:** Introduction to fuse**,** fuse law, cut -off characteristics, Time current characteristics, fuse material, HRC fuse, liquid fuse, applications of fuse. **b)Circuit Breakers – Operating principles:** Introduction, requirement of a circuit breakers, basic principle of operation of a circuit breaker, properties of arc, initiation and maintenance of arc, arc interruption theories -Slepian's theory and energy balance theory**,** Restriking voltage, recovery voltage, Rate of rise of restriking voltage, AC circuit breaking, current chopping, capacitance switching, resistance switching, Rating of Circuit breakers. **c)Circuits Breakers – Types & Construction:** SF_6 breaker, Puffer and non Puffer type of SF_6 breakers. Vacuum circuit breakers - principle of operation and constructional details. Advantages and disadvantages of different types of Circuit breakers.	5+4
2	**a)Protective Relaying Operating principles:** Requirement of Protective Relaying, Zones of protection, primary and backup protection, Essential qualities of Protective Relaying, Evolution of protective relays – Historical perspective, Classification of Protective Relays, A concise introduction to electromechanical relays, static relays and microprocessor based relays. **b)Protection philosophies:** Understanding of protection philosophies (the Physics of protection) as applicable to the unit protected - such as non-pilot over-current protection of transmission lines, transformer protection, non-pilot distance protection of transmission lines, rotating machinery protection.	4+5
3	**Embedded protection systems:** General architecture & Essential requirements of an embedded protection system – metering, protection, automation and control modules; model/component based approach in designing an embedded system; choice of OS, microprocessor architecture and digital signal processor architecture & requirements of – DMA, ADC, MAC, memory, communication controllers. Modeling formalism using UML – formal representation of requirements, temporal and spatial modeling techniques, use of finite-automata in designing of sequential control algorithms.	7+7
4	**Phasor measurement, metering and records (DSP techniques):** Definition of a phasor; DSP primer: simultaneity in sampling, sampling theorem, aliasing, DFT, digital filters – FIR, IIR, symmetric FIR filters, transform pairs and sync function, design of high pass and low pass filters; Phasor measurement algorithm; Spectral leakage and frequency tracking algorithms; Disturbance records and recorders; Introduction to synchro-phasor measurement.	6+6
5	**Substation Automation Concepts & Communication stacks:** Introduction to substation communication architecture; Quasi real time and real time communication requirements; Choice of physical layer based on the bandwidth requirements – RS-485, IEEE 802.3; Evolution of communication stacks and	4+4

	standards – MODBUS, IEC 60870-5-103, DNP 3.0, IEC 61850. A brief introduction to MODBUS; A brief introduction to IEC 61850.	

Course Outcome: At the end of the course students will be able to -
CO1: define and explain various protection devices and protection schemes.
CO2: explain the characteristics and working of various protective devices and protection schemes.
CO3: apply the basic concepts of protection systems to solve problems related to protective relaying.
CO4: analyze various protection devices and protection techniques for application to protection systems.
CO5: justify the use of various international standards related to protective Relaying.

TEXT BOOKS:
1. Power system relaying: Stanley H. Horowitz & Arun G. Phadke, Wiley, 3rd edition.
2. Power system protection and switchgear: Badri Ram & D.N Vishwakarma ,TMH Publications 2004

REFERENCE BOOK
1. Power system protection and switchgear: Bhuvanesh Oza, et.al,, Mc Graw Hill Publication, New Delhi
2. Computer relaying for power systems: Arun G. Phadke & James S. Thorp, Wiley, 2nd edition
3. **Power System protection static relays with microprocessor applications:TS Madava rao, TMH second edition, 2004.**
4. **Switchgear & Protection:** Sunil S.Rao, Khanna Publishers, 13th Edition, 2008.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*	*	*					*
CO2	*	*	*	*	*	*	*					*
CO3	*	*	*	*	*	*	*					*
CO4	*	*	*	*	*	*	*					*
CO5	*	*	*	*	*	*	*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: POWER SYSTEM OPERATION AND CONTROL		
Course Code : EE82	No. of Credits:3; L:T:P - 2:1:0	No. of hours/week: 2+2
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. To impart knowledge relevant to power system planning and operations.
2. To learn network operation, generation and transmission planning.
3. To provide an insight into elaborate concepts of Automatic Generation control for Load frequency.
4. Power system security issues and Contingency analysis.

Unit No.	Syllabus Content	No. of Hours
1	**Control center operation of power systems :** Introduction to SCADA, control center, digital computer configuration, automatic generation control, area control error, operation without central computers, parallel operation of generators.(Problems on parallel operation only)	7
2	**Automatic Generation Control:** Introduction, Load Frequency Control (single area case) Turbine speed governing system Model of speed Governing system, Turbine model, Block diagram of Load frequency control of an isolated power system. Control area concept, Proportional plus integral control, Load frequency control and Economic dispatch control, Two area load frequency control, Automatic voltage regulator.	8
3	**Control of Voltage and reactive power:** Introduction, generation and absorption of reactive power, relation between voltage, power and reactive power at a node, single machine infinite bus system, methods of voltage control, sub synchronous resonance, voltage stability, voltage collapse.	8
4	**Unit commitment:** statement of the problem, need and importance of Unit commitment, methods – priority list method, dynamic programming method (Flow chart only), constraints, spinning reserve, examples.	8
5	**Power system security:** Introduction, system state classification, Security analysis, factors affecting power system security, modeling for contingency analysis, contingency selection, contingency analysis, sensitivity factors.	8

Course Outcome: At the end of the course students will be able to -
CO1: Explain the important functions like SCADA, EMS, DMS etc., and issues involved in different activities associated with power system operation and planning.
CO2: Discuss load frequency control Techniques and methods of voltage and reactive power control.
CO3: Explain the need and Importance of unit commitment.
CO4: Analyze various Power System security issues under different operating conditions
CO5: Discuss the Recent trends in PSOC.

TEXT BOOKS:

1) Computer aided power system analysis, G L Kusic, PHI, 2010.
2) Modern Power System Analysis, I.J. Nagarath and D.P. Kothri,TMH, 2003

REFERENCE BOOK/WEBSITE LINKS:

1. Power Generation, Operation & control, AJ Wood &Woolenburg, John Wiley & Sons, 2nd edition 2009.
2. Electric power Systems, B.M Weedy and B J Cory,
3. Electric Energy Systems,Olle J Elgerd, TMH, 2008
4. Power System Stability and Control, Prabha Kundur,TMH,1993
5. Operation and control in Power Systems, PSR Murthy,B S Publications, 1998
6. Power system analysis, operation and Control, AbhijitChakrabarti, SunitaHaldar, PHI, 2nd edition 2009.
7. Power system analysis, operation and Control, S Shivaganaraju& G Sreenivasan, Pearson 2010
8. Power System operation, Robert H Miller & James H Malinowski, TMH 3rd edition 2009

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*									
CO2			*	*		*						
CO3				*		*	*		*			
CO4									*	*		
CO5											*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: TESTING & COMMISSIONING OF ELECTRICAL EQUIPMENT		
Course Code : EE831	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. Proper testing and commissioning promote long-term efficient operation of electrical generation and delivery systems.
2. Aim of the subject is to expose to testing on each piece of equipment and then commissioning.

Unit No.	Syllabus Content	Hours
1	**TRANSFORMERS:** **a. Specifications:** Power and distribution transformers as per BIS. **b. Installation:** Location, site, selection, foundation details (like bolts size, their number, etc.), code of practice for terminal plates, polarity & phase sequence, oil tanks, drying of windings and general inspection.	09
2	**TRANSFORMERS:** **a. Commissioning tests:** Following tests as per national & International Standards, volt ratio test, earth resistance, oil strength, Bucholz & other relays, tap changing gear, fans & pumps, insulation test, impulse test, polarizing index, load & temperature rise test. **b. Specific Tests:** Determination of performance curves like efficiency, regulation etc., and determination of mechanical stress under normal &abnormal conditions.	09
3	**SYNCHRONOUS MACHINES:** **a. Specifications:** As per BIS. **b. Installation:** Physical inspection, foundation details, alignments, excitation systems, cooling and control gear, drying out. **c. Commissioning Tests:** Insulation, Resistance measurement of armature & field windings, waveform & telephone interference tests, line charging capacitance. **d. Performance tests:** Various tests to estimate the performance of generator operations, slip test, maximum lagging current, maximum reluctance power tests, sudden short circuit tests, transient & sub transient parameters, measurements of sequence impedances, capacitive reactance, and separation of losses, temperature rise test, and retardation tests. **e. Factory tests:** Gap length, magnetic eccentricity, balancing vibrations, bearing performance.	12
4	**INDUCTION MOTORS:** a. **Specifications** for different types of motors, Duty, I.P. protection. **b. Installation:** Location of the motors (including the foundation details) & its control apparatus, shaft & alignment for various coupling, fitting of pulleys & coupling, drying of windings. **c. Commissioning Test:** Mechanical tests for alignment, air gap symmetry, tests for bearings, vibrations & balancing.	10
5	**INDUCTION MOTORS:** **a. Electrical Tests:** Insulation test, earth resistance, high voltage test, starting up, failure to speed up to take the load, type of test, routine test, factory test and site test (in accordance with ISI code **b. Specific Tests:** Performance & temperature raise tests, stray load losses, shaft alignment, and re-rating & special duty capability. **SWITCH GEAR & PROTECTIVE DEVICES:** Standards, types, specification, installation, commissioning tests, maintenance schedule, type & routine tests.	12

Course Outcome: At the end of the course students will be able to -

CO1: Conduct acceptance test to ensure that each piece of electrical equipment meets specification, ready for energization and conforms to the drawings.

CO2: Certify that it will operate as designed and perform as an integral part of the system.

CO3: Verify the entire system, when commissioned and following tests, operates as intended and meeting design requirements.

CO4: Acquaint to the standards

CO5: More attention is being directed to the maintenance and safe operation of electrical equipment.

TEXT BOOKS:

1. Testing & Commissioning Of Electrical Equipment **-**S. Rao, Khanna Publishers,2004
2. Testing & Commissioning Of Electrical Equipment -B .V. S. Rao, Media Promoters and Publication Pvt., Ltd.

REFERENCE BOOK/WEBSITE LINKS:

1. Relevant Bureau of Indian Standards
2. A Handbook on Operation and Maintenance of Transformers**-** H. N. S. Gowda, Published by H. N. S.Gowda,2006
3. Handbook of Switchgears**,** BHEL, TMH, 2005. J and P Transformer Book, Elsevier Publication.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*			*	*			*		*
CO2	*	*	*			*	*			*		*
CO3	*	*	*			*	*			*		*
CO4	*	*	*			*	*			*		*
CO5	*	*	*			*	*			*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: HVDC TRANSMISSION		
Course Code : EE832	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. To learn the aspects of AC and DC transmission.
2. To analysis the components required for HVDC transmission.
3. To learn the methods of control and protection of HVDC converters and systems.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction :** Historical sketch, constitution of EHV AC and DC links, comparison of AC and DC transmission systems-technical, economics and reliability, advantages and disadvantages of HVDC transmission systems, applications of DC transmission systems, Types of HVDC links, block diagram of HVDC system.	8
2	**Converter circuits:** thyristor characteristics, description of uncontrolled rectifiers, controlled rectifiers: single phase rectifiers, three phase rectifiers, choice of best configuration for HV DC systems and two level voltage source inverter.	12
3	**Analysis of the bridge converter:** Analysis of six pulse converters with grid control and no overlap, Analysis of six pulse converters with grid control and overlap greater than and less than 60 degrees, analysis of twelve pulse converters complete characteristics of rectifier and inverter.	11
4	**Control of HVDC converters and systems:** grid control, basic means of control, power reversal, limitations of manual control, constant current versus constant voltage, desired feature of control, actual control characteristics, constant -minimum -ignition –angle control, constant –current control, constant –extinction –angle control, stability of control, tap changer control, power control.	12
5	**PROTECTION:** Introduction, DC reactor, surge arresters, over voltage protection, over current protection, voltage oscillations and valve dampers, current oscillations and anode dampers, DC line oscillations and line dampers, clear line faults and reenergizing the line.	09

Course Outcome: At the end of the course students will be able to -

CO1: recall and compare the different power transmission systems.

CO2: understand ideal requirements of HVDC transmission systems.

CO3: analysis the different converter circuits and select the suitable converter circuit for HVDC systems.

CO4: Analyze controllers for HVDC systems.

CO5: Understand the importance of protection and its requirements for HVDC systems.

TEXT BOOKS:

1. EW Kimbark, “Direct current Transmission”
2. K.R.Padiyar, “High Voltage D.C.Power Transmission System”, New Age International Publishers Ltd.

REFERENCE BOOK/WEBSITE LINKS:

1. Jos Arrillaga, Y.H.Liu and Mevelle R Watson, “High Voltage Power Transmission: The HVDC Options”, Wiley Interscience.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*			*	*	*		*		*
CO2	*			*	*		*					
CO3	*	*	*	*								
CO4	*	*	*	*							*	
CO5	*		*	*		*	*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: INSULATION ENGINEERING		
Course Code : EE833	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. To introduce concepts of dielectric, dielectric stress in various electrical equipments.
2. To introduce dielectrics phenomena.
3. To analyze failure of dielectrics due to ageing mechanism.

Unit No.	Syllabus Content	No. of Hours
1	**Electrostatic Field, their Control and Estimations**: Electric Field Intensity, Electric Strength, Classification of Electric Fields, Degree of Uniformity of Electric Fields, control of Electric field Intensity (stress control), Estimation of Electric Field Intensity, Basic Equations for potential and Field Intensity in Electrostatic Fields.	11
2	**Insulation System in Power System Apparatus**: Insulation system in capacitors, bushings and transformers. Modes of failure of insulation systems. Insulations used in rotating machines.	09
3	**Dielectric Phenomena**: Dielectric phenomena in insulation – Permittivity and Loss Tangent. Phenomena of Polarization, depolarization, Relaxation in solids and liquids. Breakdown strengths of Dielectric Media**,** Influence of type of electrical excitation (AC, DC and Impulse), Physics of breakdown phenomena in vacuum gaps. Concept of self-restoring and non self – restoring insulation, enclosed and exposed insulation	11
4	**Gaseous Insulation:** Requirement of gaseous insulation. Breakdown processes: types of collision, Elastic and in-elastic, collision cross-section, Mobility of ions, Diffusion of charges, Emission of radiation and excitation, various secondary processes, Gas insulated substations. Overvoltage, Surge arrestors and insulation coordination	10
5	**Ageing Phenomena:** Failure of electric insulation due to ageing. Ageing mechanisms- Thermal ageing, Electrical ageing, combined thermal and electrical ageing. Analysis of insulation failure data, Power law model, Graphical estimation of power law constants, ageing data.	11

Course Outcome: At the end of the course students will be able to -
CO1: Solve electric field problems related to dielectrics.
CO2: To understand insulation/insulation systems used in power system apparatus
CO3: To understand the dielectric phenomena in insulation and influence of excitations.
CO4: To understand the concept of gaseous insulation, insulation coordination and influence of over voltages
CO5: Understand and analyze failure of insulation due to ageing.

TEXT BOOKS:

1. Methods of statistical analysis and life data. Hann N.R. Schafer R.E. and Singapore wall N.D. John Wiley and sons, New York, 2002.
2. High voltage Engineering fundamentals. E. Kufell and W.S. Zaengl, and J. Kufell, 2nd edition, Elsevier 2005

REFERENCE BOOK/WEBSITE LINKS:

1. Electrical breakdown of gases. J.M. Meek and J.D. Craggs, "Oxford university press, 11953
2. Fundamentals of gaseous ionization and plasma electronics. Nasser E. John Wiley Interscience, New York, 1971.
3. Gas Insulated Substations. M.S. Naidu, I K International Publishing House, 2008 Edition.
4. High Voltage Insulation Engineering. Ravindra Arora, Wolfgang Mosch, New age International Publishers Ltd.
5. High voltage Engineering. M.S. Naidu and V Kamaraju, TMH, 4th edition, 2008.
6. Electrical insulation.Bradwell A. Peter Peregrinus Ltd, London, 1993.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*		*								*
CO2	*	*		*								*
CO3	*	*		*								*
CO4	*	*		*								*
CO5	*	*		*								*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: ARTIFICIAL INTELLIGENCEAPPLICATIONS TO POWER SYSTEMS		
Course Code : EE834	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To give knowledge about Sparsity oriented Programming.
2. This course is an introduction to the basic concepts of Artificial Intelligence, with illustrations of current state of the art research and applications.
3. To have knowledge representation for the engineering issues underlying the design of AI systems.
4. To have a basic proficiency in a traditional AI language including an ability to write simple to intermediate programs and an ability to understand code written in that language.
5. To and blind and heuristic search, as well as an understanding of other topics such as minimax, resolution, etc. that play an important role in AI program.

Unit No.	Syllabus Content	No. of Hours
1	**Sparsity oriented Programming**: Introduction, physical structure and sparsity, pivoting, conservation of sparsity by optimal ordering of buses, schemes for ordering, UD table storage scheme.	**09**
2	**Artificial Intelligence:** What is AI? Definitions, history and evolution, essential abilities of intelligence, AI applications; Problem solving: problem characteristics, problem search strategies, forward and backward reasoning, AND-OR graphs, game trees, search methods-informed and uninformed search, breadth first search and depth first search methods	**09**
3	**Knowledge representation**: logical formalisms: propositional and predicate logic: syntax and semantics, wffs, clause form expressions, resolution- use of RRTs for proofs and answers, examples from electric power systems, Non-monotonic logic: TMS, modal, temporal and fuzzy logic.	**12**
4	**a)Structured representation** of knowledge: ISA/ISPART trees, semantic nets, frames and scripts, examples from electric systems. **b)Expert systems:** Basic components, forward and backward chaining, ES features, ES development, ES categories, ES tools and examples from electric drive systems.	**12**
5	**AI languages:** LISP and ProLog - Introduction, sample segments, LisP primitives, list manipulation functions, function predicates, variables, iteration and recursion, property lists, sample programs for examples from electric power systems.	**10**

Course Outcome: At the end of the course students will be able to -

CO1: Understand the basic issues of knowledge representation of Sparsity oriented programming.

CO2: Appreciation for and understanding of both the achievements of AI and the theory underlying those achievements.

CO3: Learn about knowledge representation on logical formalisms.

CO4: Promote and lead research in various aspects related to Intelligent Systems.

CO5: Cover a broad spectrum of AI concepts and methods and apply some of them in programming assignments.

TEXT BOOKS:

1) Introduction to Artificial Intelligence and Expert Systems, D.W.Patterson,PHI, 2009.
2) Computer Methods for Circuit Analysis and Design, J.Vlach and Singhal, CBS Publishers, 1986.

REFERENCE BOOK/WEBSITE LINKS:

3) Artificial Intelligence, Rich, Elaine, Kevin Knight, TMH, 3rd Edition, 2008.
4) Introduction to AI, Charniak E. and Mcdermott D ,Pearson Education.
5) Problem Solving Methods in AI, Nils J.Nilson ,McGraw-Hill, 1971.
6) Principles of AI**,** Nils J.Nilson, Berlin Springer-Verlag, 1980

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*					*			*		*	
CO2	*		*			*			*		*	
CO3			*			*						
CO4	*		*			*			*		*	
CO5			*			*			*		*	

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: COMPUTER CONTROL OF ELECTRIC DRIVES		
Course Code : EE835	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. Introduction to modern digital control of drives, different types of sensors and to study the concept of ac machine drives in detail.
2. To learn phase controlled converters, principles of slip power recovery schemes and to know about principle of Vector Control of AC Drives.
3. To learn about Applications of expert system to Drives.

Unit No.	Syllabus Content	No. of Hours
1	**Review of Micro Controllers in Industrial Drives System:** Typical Micro controller's 8 bit 16 bit (only block diagram) Digital Data Acquisition system, voltage sensors, current sensors, frequency sensors and speed sensors.	10
2	**AC Machine Drives:** general classification and National Electrical Manufacturer Association (NEMA) classification, Speed control of Induction motors with variable voltage constant frequency, constant voltage variable frequency, (v/f) constant operation, drive operating regions. Variable stator current operation. Effect of Harmonics.	11
3	**a)Phase Controlled Converters:** Converter controls, Linear firing angle control, cosine wave crossing control, and phase locked Oscillator principle, Electromagnetic Interference (EMI) and line power quality problems, cyclo converters, voltage fed converters, Rectifiers, and Current fed converters. **b)Principles of Slip Power Recovery Schemes**: Static Kramer's drive system, block schematic diagram, phasor diagram and limitations, Static Scherbins scheme system using D.C link converters with cyclo converter modes of operation, modified Scherbins Drive for variable source, constant frequency (VSCF) generation.	11
4	**Principle of Vector Control of AC Drives:** Phasor diagram, digital Implementation block diagram, Flux vector estimation, indirect vector control block diagram with open loop flux control, synchronous motor control with compensation.	10
5	**Expert System Application to drives (Only Block Diagram):** Expert system shell, Design methodology, ES based P-I tuning of vector controlled drives system, Fuzzy logic control for speed controller in vector control drives, structure of fuzzy control in feedback system.	10

Course Outcome: At the end of the course students will be able to -
CO1: Learn about Digital Data Acquisition System and all types of sensors in detail.
CO2: Understand the concept of AC Machine Drives operation and characteristics.
CO3: Know about different types of phase controlled converters.
CO4: Learn about digital implementation and principle of vector control of AC drives.
CO5: Learn design methodology of drives and fuzzy logic control feedback system.

TEXT BOOKS:
1. Power Electronics & Motor Drives. BimalK.Bose, Elsevier 2006
2. Modern Power Electronics & Drives. Bimal K. Bose, Pearson Education 2003.

REFERENCE BOOK/WEBSITE LINKS:
1. Advanced Microprocessor and Interfacing. Badri Ram, TMH, 1st Edition.

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*		*								*
CO2	*	*			*							*
CO3	*	*			*							*
CO4	*	*		*		*						
CO5	*	*										*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: ELECTROMAGNETIC COMPATIBILITY*		
Course Code : EE836	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. Learning concepts and overview of electromagnetic compatibility (EMC) and EMI that covers the history of EMI occurrence.
2. To understand the worldwide EMC regulatory requirements.
3. Discussion of behaviors of passive components at high frequencies and their impacts on EMC.
4. To understand Cabling, Grounding and Shielding Techniques.
5. To study Electrostatic discharge (ESD) and its effects.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction:** Designing for Electromagnetic compatibility. EMC regulations. Typical Noise path. Use of network theory. Methods of noise coupling miscellaneous noise sources. Methods of eliminating interference.	10
2	**Cabling:** Capacitive coupling. Effect of shield on capacitive coupling. Inductive coupling, mutual inductance calculations. Effect of shield on magnetic coupling. Magnetic coupling between shield and inner conductor. Shielding to prevent magnetic radiation, Shielding a receptor against magnetic fields, shield transfer impedance, coaxial cable versus shielded twisted pair, braided shields, effect of pigtails, ribbon cables. Electrically long cables	11
3	**Grounding:** Safety grounds, signal grounds single point ground systems hybrid grounds, multipoint ground systems, functional ground layout, practical low frequency grounding, hardware grounds, single ground reference for a circuit amplifier shields, grounding of cable shields, ground loops, and methods for breaking ground loops. Differential amplifiers shields, grounding at high frequency, guard shields and guarded meters.	11
4	**Shielding:** Near fields and far fields. Characteristic and wave impedance, shielding effectiveness, absorption loss, reflection loss, composite adsorption and reflection loss. Apertures, conductive gaskets, conductive windows, conductive coating, cavity resonance.	10
5	**Electrostatic discharges :** Static Generation, human body model, static discharge, ESD Protection in equipment design, software and ESD protection, ESD protection, ESD versus EMC	10

Course Outcome: At the end of the course students will be able to -

CO1: Explain and Understand EMC regulatory requirements in North America, European Community and Asia Pacific region.

CO2: Select proper passive components at high frequencies to minimize unwanted EMI behaviors.

CO3: Apply the correct grounding and shielding methodologies for specific product groups and operating frequencies.

CO4: Discuss non-linear phenomena and (ESD) with good design practices.

CO5: Discuss the basic setup for a product-under-test to meet a specific EMC standard.

TEXT BOOKS:

1) Noise Reduction Techniques in Electronic Systems, Henry W Otto, Second Edition John Wiley and Sons 1989.
2) Electromagnetic Compatibility Engineering, H W Otto, Wiley, Aug.2009

REFERENCE BOOK/WEBSITE LINKS:

1. Engineering Electromagnetic Compatibility, V Prasad Kodali, Wiley IEEE press, 2nd Edition, 2001
2. Introduction to Electromagnetic Compatibility, Clayton R Paul,WileyInterscience Publications,2nd edition,2006
3. www.autoemc.net
4. http://www.ofcom.org.uk/website/regulator-archives
5. www.fcc.gov/engineering-technology/electromagnetic-compatibility-division/radio-frequency-safety/faq/rf-safety

INSTRUCTIONS TO PAPER SETTERS

1. The question paper will have **10** questions.
2. Each full question is for 20 marks.
3. There will be 2 full questions (with a maximum of three sub questions in one full question) from each unit.

Students shall answer 5 full questions, selecting one full question from each unit.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*		*		*	*	*		
CO2	*		*	*	*					*		
CO3	*	*	*	*			*			*		
CO4	*	*	*	*			*			*		
CO5	*	*	*	*	*	*	*			*		*

Panchajanya Vidya Peetha Welfare Trust (Regd)

Dr. Ambedkar Institute of Technology

Aided by Govt. of Karnataka, An Autonomous Institution, Affiliated to Visvesvaraya Technological University, Belagavi, Approved by All India Council for Technical Education (AICTE), New Delhi, Accredited by NBA and NAAC with 'A' Grade

BDA Outer Ring Road, Mallathahalli, Bengaluru - 560 056

Ref. No. .... Date : 05-01-2023

Subjects focusing on Employability/Entrepreneurship/Skill development for the year 2018-19

S.No	Subject Code	Subject
1.	EE31	Analog Electronic Circuits
2.	EE32	Logic Design
3.	EE33	Network Analysis
4.	EE34	Transformer and Induction Machines
5.	EEL35	Electronic Circuits Lab
6.	EEL36	Logic Design Lab
7.	EEL37	Basic Electrical Lab
8.	EE41	Microcontrollers
9.	EE42	Control Systems
10.	EE43	Field Theory
11.	EE44	Power Electronics - I
12.	EE45	Generation, Transmission & Distribution
13.	EEL46	Microcontroller Lab
14.	EEL47	Transformer and Induction Machines Lab
15.	EE51	Signals and Systems
16.	EE52	Power Electronics II
17.	EE53	DC Machines & Synchronous Machines
18.	EEL56	Control Systems Lab
19.	EEL57	Power Electronics –II Lab
20.	EEL58	Simulation Lab
21.	EE541	Advanced Instrumentation System
22.	EE542	Embedded Systems
23.	EE543	Modern Control Theory
24.	EE551	VLSI Circuits & Design
25.	EE552	Operating System
26.	EE553	Linear IC's and Applications
27.	EE61	Power Systems Analysis
28.	EE62	Electrical Machine Design
29.	EE63	Digital Signal Processing
30.	EEL66	DC Machines & Synchronous Machines Lab
31.	EEL67	Digital Signal Processing Lab
32.	EE641	Electrical Power Utilization
33.	EE642	Electrical Design, Estimating and Costing
34.	EE643	Programmable Logic Controllers
35.	EE651	Power System Planning
36.	EE652	Special Machines
37.	EE653	Reactive Power Management

Ph : 23211232, Fax : 080-23217789, E-mail : principal@dr-ait.org, Website : www.dr-ait.org

38.	EE71	Computer Techniques in Power System Analysis
39.	EE72	High Voltage Engineering
40.	EEL74	Relay & HV Lab
41.	EEL75	Power Systems Simulation Lab
42.	EEL76	Electrical Drawing
43.	EE731	Flexible AC Transmission Systems(FACTS)
44.	EE732	Energy Auditing & Demand Side Management
45.	EE733	Power Systems Dynamics & Stability
46.	EE734	Embedded Systems
47.	EE735	Fuzzy Logic
48.	EE736	Artificial Neural Network
49.	EE737	Electrical Power Quality
50.	EE738	Advanced Power Electronics
51.	EE81	Modern Power System Protection
52.	EE82	Power System Operation & Control
53.	EE831	Testing & Commissioning of Electrical Equipment
54.	EE832	HVDC Transmission
55.	EE833	Insulation Engineering
56.	EE834	Artificial Intelligence Applications to Power Systems
57.	EE835	Computer Control of Electrical Drives
58.	EEE836	Micro and Smart System Design
59.	EE837	Advanced Control System
60.	EE838	Electromagnetic Compatibility

BOS Chairman **Principal**

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING III SEMSTER		
Course Title : ANALOG ELECTRONIC CIRCUITS		
Course Code : EE31	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To study the basic concepts of diode circuits such as clippers, clampers and rectifiers
2. To analyze and design of different transistor circuit biasing along with bias stabilization.
3. To study the modeling of transistor& to analyze general, feedback and power amplifiers.
4. The basics concept of oscillators and FET amplifiers along with characteristics

Unit No.	Syllabus Content	No. of Hours
1	**Diode Circuits***:* Diode resistance, diode equivalent circuits, transition and diffusion capacitance, load line analysis, rectifiers, clippers and clampers.	10
2	**Transistor Biasing***:* Operating point, fixed bias circuits, emitter stabilized biased circuits, voltage divider bias, dc bias with voltage feedback, miscellaneous bias configurations. Design considerations. Transistor as a switch. Pnp transistors. Bias stabilization.	10
3	**A) Transistor Low Frequency Model***:* BJT modeling, hybrid equivalent model, approximate model. **B) Transistor Frequency Response***:* General frequency considerations, low frequency response, miller effect capacitance, high frequency response.	10
4	**A) General Amplifiers:** Cascade connections, cascode connections, Darlington connections. **B) Feedback Amplifiers:** Feedback concept, types of feedback, block diagram approach **C) Power Amplifiers**: Definitions and amplifier types, series fed class a amplifier, transformer coupled class A amplifiers & class B amplifiers.	11
5	**A) Oscillators:** Principle of operation, phase shift oscillator, tuned oscillator circuits, crystal oscillator. (BJT versions) **B) FET Amplifiers***:* FET small signal model, biasing of FET, common drain common gate configurations, MOSFET, FET amplifier networks.	11

Course Outcome: At the end of the course students will be able to -

CO1. Recall the basic diode circuits and define various wave shaping circuits.
CO2. Explain the working of transistor biasing circuits and locate quiescent point.
CO3. Analyze the models of transistor & FET amplifier circuits.
CO4. Design and develop various transistor amplifier circuits.
CO5. Construct and solve the transistor oscillator circuits.

TEXT BOOKS:

1. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education. 9^{TH} Edition.

REFERENCE BOOK/WEBSITE LINKS:

1. Jacob Millman & Christos C. Halkias, Integrated Electronics, ,Tata McGraw Hill, 1991 Edition
2. David A. Bell, Electronic Devices and Circuits, PHI, 4^{th} Edition, 2004

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.

3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-I**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*				*	*		*	*
CO2	*	*	*	*				*	*		*	*
CO3	*	*	*	*				*	*		*	*
CO4	*	*	*	*				*	*		*	*
CO5	*	*	*	*				*	*		*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING III SEMSTER		
Course Title : LOGIC DESIGN		
Course Code : EE32	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week:4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To provide a comprehensive introduction to fundamentals of digital logic design. Karnaugh Map Techniques, Quine Mckluskey and VEM Techniques.
2. To design and analyze combinational and sequential circuits.

Unit No.	Syllabus Content	No. of Hours
1	**Principles of Combinational Logic-I:a)** Introduction to Boolean algebra, definition of combinational logic ,canonical forms, Generation of switching equations from truth tables, simplification and realisation of Boolean expressions using Boolean laws. **b) Karnaugh maps**-3, 4 and 5 variables, Incompletely specified functions (Don't Care terms), Simplifying Max term equations.	10
2	**Principles of Combinational Logic-II:** Limitations of K-Maps, Quine-McCluskey Tabulation Algorithm, Quine-McCluskey using don't care terms, Map entered variables (one and two map variables).	10
3	**a) Analysis and design of combinational logic – I:** General approach for design of combinational logic circuits, code converters, decoders-BCD decoders (Logic design using decoders), encoders, priority encoder. **b) Analysis and design of combinational logic – II:** Digital multiplexers-using multiplexers as Boolean function generators. Binary adders and subtractors, binary comparators. (1 bit, two bits and 4 bits)	12
4	**Sequential Circuits – 1:** Basic bistable element, latches, SR latch, application of SR latch, switch debouncer, SR latch, gated SR latch, gated D latch, master-slave flip-flops (pulse-triggered flip-flops): The master-slave SR flip-flops, master-slave JK flip-flops, edge triggered flip-flops: The positive edge-triggered D flip-flops, negative-edge triggered D flip-flop	10
5	**Sequential Circuits – 2:** Characteristic equations, registers, counters - binary ripple counters, synchronous binary counters, counters based on shift registers (ring and Johnson), design of a synchronous counters, design of a synchronous mod-6 counter using clocked JK flip-flops, design of a synchronous mod-6 counter using clocked D, T, or SR flip-flops.	10

Course Outcome: At the end of the course students will be able to -
CO1: To demonstrate knowledge of binary number theory, Boolean algebra and binary codes, analyze and design combinational systems using standard gates and minimization methods (Karnaugh Maps up to 5 variables)
CO2: To understand the limitations of K map and use computerized simplification Techniques (Quine Mckluskey tabulation and VEM methods).
CO3: To analyze and design combinational systems composed of standard combinational modules, such as multiplexers, decoders, encoders and binary comparators.
CO4: To demonstrate knowledge of simple synchronous sequential systems (flip-flops and latches).
CO5: To analyze and design sequential systems composed of standard sequential modules, such as counters and registers.

TEXT BOOKS:

1.Digital Logic Applications and Design, John M Yarbrough, Thomson Learning, 2001.

2.Digital Principles and Design, Donald D Givone, Tata McGraw Hill Edition, 2002.

REFERENCE BOOK/WEBSITE LINKS:

1.Fundamentals of logic design, Charles H Roth, Jr; Thomson Learning, 2004.

2.Logic and computer design Fundamentals, Mono and Kim, Pearson, Second edition, 2001.

INSTRUCTIONS TO PAPER SETTERS
1: Students have to answer five full questions of 20 marks each.
2: Questions 3 and 4 and questions 6 and 7 are to be from unit 3 and unit 5 respectively. Students have to answer Q.3 or Q.4 and Q.6 or Q.7.
3. Questions 1, 2 and 5 are to be set from units 1, 2 and 4 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*							*		*
CO2	*	*	*							*		*
CO3	*	*	*							*		*
CO4	*	*	*							*		*
CO5	*	*	*							*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING III SEMSTER		
Course Title : NETWORK ANALYSIS		
Course Code : EE33	No. of Credits:4; L:T:P - 3:2:0	No. of hours/week:3+2
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39+26

Course Objective:
1. To provide fundamental knowledge of AC and DC networks. And apply network theorems for various electrical circuits.
2. To determine the solution of electrical network using Laplace transformations, Steady state behavior of circuit elements and frequency response in resonant circuits

Unit No.	Syllabus Content	No. of Hours
1	**Basic Concepts**: Practical sources, source transformations, network reduction using star – delta transformation, loop and node analysis with linearly dependent and independent sources for DC and AC networks. Concepts of super node and super mesh.	7+5
2	**Network Theorems:** Superposition theorem**,** Reciprocity theorem, Thevinin's theorem and Norton's theorem, Maximum Power transfer theorem.	8+5
3	**Laplace Transformation & Applications**: Solution of networks, step, ramp and impulse responses waveform Synthesis.	7+**5**
4	**a) Resonant Circuits:** Series and parallel resonance, frequency-response of series and parallel circuits, Q factor, bandwidth. **b) Transient behavior and initial conditions**: Behavior of circuit elements under switching condition and their representation, Evaluation of initial and final conditions in RL, RC and RLC circuits for DC excitations.	8+5
5	**Network Topology:** Graph of a network, Concept of tree and co-tree, incidence matrix, tie-set and cut-set schedules, Formulation of equilibrium equations in matrix form, solution of resistive networks and principle of duality**.** **b) Two port network parameters:** Definition and Calculation of z, y, h and ABCD transmission parameters. Modeling with these parameters.	9+6

Course Outcome: At the end of the course students will be able to -
CO1: Understand the concepts of nodal and mesh methods.
CO2: Express complex circuits in their simple form using different theorems.
CO3: Analyze the circuit using time and frequency domain.
CO4: Analyze and design resonant circuits.
CO5: Model the various electrical networks using two port circuits.

TEXT BOOKS:

1.**Engineering Circuit Analysis,** Hayt, Kemmerly and Durbin,TMH , 7th Edition, 2010
2. Networks and systems, Roy Choudhury, New Age International Publications. 2nd edition, 2006 re-print,

REFERENCE BOOK/WEBSITE LINKS:

1. Introductory Circuit Analysis, Robert L and Boylestad, Pearson, print, 2011
2. Network Analysis and Synthesis, A K Chakraborty, S P Ghosh, TMH, 1ST Edition, 2009.
3. Electric Circuits, M Nahvi and J A Edminister, Schaum's Outlines TMH, 5th Edition, 2009**.**
4. Network Analysis, M. E. Van Valkenburg, PHI, 3rd Edition, Reprint 2009.
5. Analysis of Linear Systems, David K. Cheng, Narosa Publishing House, 11th reprint, 2002.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.
2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.
3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*								*
CO2	*	*	*	*								*
CO3	*	*	*	*						*		*
CO4	*	*	*	*						*		*
CO5	*	*	*	*								*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING III SEMSTER		
Course Title : TRANSFORMERS AND INDUCTION MACHIES		
Course Code : EE34	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To understand the concepts of transformers, induction machines and their analysis.
2. To evaluate the performance of transformers and induction machines.
3. To analyze the concepts to operate transformers in different configurations and operate in parallel.
4. To understand starters, methods of speed control of induction motor and induction generator.
5. To analyze induction motor with high torque rotors construction.

Unit No.	Syllabus Content	No. of Hours
1	**Basic Concepts: Review of p**rinciple of operation, constructional details of shell type and core type single-phase and three-phase transformers, EMF equation, losses and commercial efficiency, condition for maximum efficiency (No question shall be set from the review portion). Concept of ideal transformer, operation of practical power transformer under no load and on load -with phasor diagrams. Equivalent circuit, Open circuit and Short circuit tests, calculation of parameters of equivalent circuit and predetermination of efficiency-commercial and all-day	10
2	**Transformer continuation: Voltage r**egulation and its significance. Objects of testing of transformers, polarity test, Sumpner's test. **Three-phase Transformers:** Introduction, choice between single unit three-phase transformer and bank of single-phase transformers. Transformer connection for three phase operation – star/star, delta/delta, star/delta, delta /star and V/V**.** Phase conversion - Scott connection for three-phase to two-phase conversion. Labeling of three-phase transformer terminals. Current inrush in transformers.	08
3	**(a) Parallel operation (Single-phase & Three-phase)**: Need, conditions to be satisfied for parallel operation. Load sharing in case of similar and dissimilar transformers. **(b) Instrument Transformers:** Current transformer and Potential transformer. **(c) Three phase Induction Machines: Review of c**oncept of rotating magnetic field. Principle of operation, construction of squirrel-cage, slip-ring induction motor (No question shall be set from the review portion).	10
4	**(a)** Characteristic Induction Motor continuation: Slip, torque, torque-slip characteristic. Maximum torque. **p**hasor diagram of induction motor on no-load and on load. Equivalent circuit, losses, efficiency. No-load and blocked rotor tests. Circle diagram and performance evaluation of the motor. Cogging and crawling. **(b)Starters & Speed Control of Three-phase Induction Motors:** Need for starter. Direct on line (DOL) starters, Star-Delta and autotransformer starting. Rotor resistance starting. Soft (electronic) starters. Speed control - voltage, frequency, and rotor resistance.	12
5	**(a) High torque rotors -** Double Cage and deep bar rotor, Equivalent circuit and performance evaluation of double cage induction motor. Induction generator – externally excited and self-excited. Importance of induction generators. **(b) Single-phase Induction Motor:** Double revolving field theory and principle	12

	of operation. Types of single-phase induction motors: split-phase, capacitor start, shaded pole motors. Applications.	

Course Outcome: At the end of the course students will be able to -

CO1: Explain the construction, operation of transformer and induction machines (1-phase and 3-phase).

CO2: Understand the different connections for the three phase operations, advantages and applications.

CO3: Evaluate the performance of transformers and induction machines.

CO4: Analyze induction motors with different rotors and as induction generator.

CO5: Understand the different starters and speed control techniques of three-phase induction motors.

TEXT BOOKS:

1. **Electric Machines,** I. J. Nagrath and D. P. Kothari, T.M.H, 4th Edition, 2010.
2. **Electrical technology-AC & DC Machines Vol-2, B L Theraja, S Chand Publishers.**

REFERENCE BOOK/WEBSITE LINKS:

1. **Performance and Design of A.C. Machines,** M. G. Say, C.B.S Publishers, 3rd Edition, 2002.
2. **Theory of Alternating Current Machines,** Alexander Langsdorf, T.M.H, 2nd edition, 2001.
3. **Electrical Machines and Transformers**, Kosow, Pearson, 2nd edition, 2007.
4. **Electric Machines, Mulukuntla S.Sarma, MukeshK.Pathak, CengageLearing, Firstedition, 2009.**

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.

3: Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*								*
CO2	*	*		*								*
CO3	*	*	*		*						*	*
CO4	*	*		*	*						*	*
CO5	*	*		*	*						*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU – 560056 ELECTRICAL AND ELECTRONICS ENGINEERING III SEMSTER		
Course Title : ELECTRONIC CIRCUITS LAB		
Course Code : EEL35	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

1. To construct various diode circuits to shape the waveforms to given specifications.
2. Design & construct circuits to verify basic theorems.
3. Design resonant circuits to resonate at required frequencies.
4. Design and test various amplifier circuits.
5. Design and verify circuits to oscillate at specified frequency.

Unit No.	Syllabus Content
	Introduction: Use of bread board, CRO, power supplies, signal generators, DRBs, DIBs, DCBs; color codes, resistors, inductors, capacitors, rheostats, multimeters; transistors, diodes; device data sheets.
1	Design and testing of diode clipping single & double ended circuits for peak clipping.
2	Design and testing of diode clipping single& double ended circuits for peak detection.
3	Design and testing of diode clamping circuits.
4	Testing of half wave, full wave and bridge rectifier circuits with and without capacitor filter, determination of ripple factor, regulation and efficiency.
5	Verification of Thevinin's theorem and maximum power transfer theorem for DC circuits.
6	Characteristics of series and parallel resonant circuits.
7	Design of RC coupled single stage amplifier and determination of the gain-frequency response, input and output impedances.
8	Design of BJT Darlington emitter follower circuit and determination of the gain, input and output impedances.
9	Design and testing for the performance of BJT-RC Phase shift oscillator for $f_0 \leq 10$ kHz
10	Design and testing for the performance of BJT-RC Hartley and Colpitt's oscillator for $f_0 \geq 100$ kHz
11	Design and experiment on BJT -crystal oscillator for $f_0 > 1$ MHz
12	Design of RC coupled two stage amplifier and determination of the gain-frequency response, input and output impedances.*
13	Design and testing of class B push pull power amplifier.*
	*** - Experiments beyond the syllabus**

Course Outcome: At the end of the course students will be able to -
CO1. Explain the working of diode wave shaping circuits and to draw transfer characteristics.
CO2. Build these circuit to verify the network theorems.
CO3. Test the resonant circuits resonating at required frequency.
CO4. Design of amplifier circuit, draw frequency response and determine input and output impedances
CO5. Construct and test transistor circuits to oscillate at desired frequencies.

REFERENCES:

1. Robert L. Boylestad and Louis NashelskyElectronic Devices and Circuit Theory, PHI/Pearson Education. 9TH Edition.
2. Laboratory Manual

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*	*					*	*	*
CO2	*	*		*	*					*	*	*
CO3	*	*		*	*					*	*	*
CO4	*	*		*	*					*	*	*
CO5	*	*		*	*					*	*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING III SEMSTER		
Course Title : LOGIC DESIGN LAB		
Course Code : EEL36	No. of Credits:1.5; L:T:P - 0:0:1.5	No. of hours/week:3
Exam Duration: 3 hrs.	CIE + SEE =50+ 50 = 100 Marks	

Course Objective:

1. To use the theoretical Knowledge and demonstrate the use of Boolean algebra / Postulates, K map techniques to design logic circuits using logic gates & solve Boolean Expressions.
2. To design and Analyze Combinational and sequential circuits such as Adders, Subtractors, Decoders, Encoders, Mux/Demux, Registers and counters.

Unit No.	Syllabus Content	No. of Hours
	Introduction: Use of IC Trainer Kits, Testing & Identification of ICs, IC Data sheets.	3
1	Simplification and realization of Boolean expressions using logic gates / universal gates.	3
2	Realization of half / full Adder and half/full Subtractor using Logic gates.	3
3	(i) Realization of parallel adder/Subtractors using 7483 chip (ii) BCD to Excess-3 code conversion and vice versa.	3
4	Realization of Binary to gray code converter and vice versa.	3
5	MUX / DEMUX use of 74153, 74139 for arithmetic circuits and code conversion.	3
6	MUX / DEMUX use of 74153, 74139 for arithmetic circuits and code conversion.	3
7	Realization of One / Two bit comparator & study of 7485 magnitude comparator.	3
8	Use of (a) decoder chip to drive LED / LCD display and (b) Priority Encoder.	3
9	Truth table verification of flip flops: (i) JK Master slave (ii) T type and (iii) D type.	3
10	Realization of 3 bit counters as a sequential circuit & Mod-N counter design (Using IC’s: 7476, 7490, 74193).	3
11	Shift left, Shift right, SIPO, SISO, PISO, PIPO operations using IC: 7495S.*	3
12	Design and testing of Ring Counter / Johnson Counter using IC 7495.*	3
	*** - Experiments beyond the syllabus**	

Course Outcome: At the end of the course students will be able to -
CO1: Have a clear understanding of various ICs, Logic gates and other components used in Digital logic circuit design.
CO2: Has Boolean theorems/K-Maps simplify and realize Boolean expressions.
CO3: Design and implement various code converters.
CO4: Design and implement combinational circuits for various digital applications.
CO5: Design and implement sequential circuits

REFERENCES:

1.Digital Lab Primer, K.A. Krishnamurthy, Pearson Education Asia publications, 2003

2.Laboratory Manual

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*		*				*	*		*
CO2	*	*	*		*				*	*		*
CO3	*	*	*		*				*	*		*
CO4	*	*	*		*				*	*		*
CO5	*	*	*		*				*	*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU – 560056
ELECTRICAL AND ELECTRONICS ENGINEERING
III SEMSTER

Course Title : BASIC ELECTRICAL LAB		
Course Code : EEL37	No. of Credits:1; L:T:P - 0:0:1	No. of hours/week:2
Exam Duration: 3 hrs.	CIE + SEE =50+ 50 = 100 Marks	

Course Objective:
Student will learn different measurement methods to find electrical parameters; also learn to find performance of DC generators and transformers.

Unit No.	Syllabus Content	No. of Hours
1	Measurement of resistance by V-I method/ Wheat stone's bridge.	2
2	Measurement of inductance by 3-voltmetersand ammeter method/ ammeter, voltmeter and wattmeter method.	2
3	Improvement of Power and Power factor of a Fluorescent Lamp.	2
4	Two-way and Three- way control of a Fluorescent lamp.	2
5	Calibration of a 1-phase energy meter.	2
6	Open circuit characteristics of DC shunt Generator.	2
7	Measurement of three phase power: a) Resistive load b) R-L Load.	2
8	Cumulative and differential connection of inductors in additive and subtractive polarities.	2
9	Display of no-load current waveform of a transformer.	2
10	Determination of percentage efficiency of transformer by direct loading.	2
11	Wiring Practices*	2
12	Demonstration of working of MCB*	2
	*** - Experiments beyond the syllabus**	

Course Outcome: At the end of the course students will be able to -
CO1: Measure the basic electrical parameters.
CO2: Measure the basic electrical quantities.
CO3: To evaluate the performance of transformer.
CO4: To assess the magnetization characteristics of electrical machines
CO5: Practice simple wiring to control the electrical devices

REFERENCES:

Laboratory Manual

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*								*		
CO2	*	*		*						*		
CO3	*	*		*						*		
CO4	*	*		*						*		
CO5	*	*		*						*		

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : MICROCONTROLLER		
Course Code : EE41	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:
1.To understand the concept and Architecture of Microcontroller, logical Instruction & Assembly programming.
2. To learn branching Instructions & C- programming,
3. To learn timer operation, modes of operation, interrupts, serial programming, Interfacing of ADC, DAC, Motor, LCD & Keyboard.

Unit No.	Syllabus Content	No. of Hours
1	**The 8051 Architecture:** Introduction, 8051 microcontroller hardware, input/output pins, ports, circuits, external memory, counter and timers, serial data input/output, interrupts.	7
2	**Addressing Modes and Operations:** Introduction, addressing modes, external data transfer, code memory, read only data moves/indexed addressing mode, push and pop. Data exchanges, example programs; byte level logical operations, bit level logical operations, rotate and swap operations, example programs. arithmetic operations: Flags, incrementing and decrementing, addition ,subtraction, multiplication and division, decimal arithmetic, program examples	8
3	**Jump and Call Instructions:** The Jump and CALL program range, jumps, calls and subroutines, interrupts and returns, more details on interrupts, program example.8051 programming in c: data types and time delays in 8051 c, I/O programming, logic operations, data conversion programs, accessing code ROM space, data serialization.	7
4	**Timer / Counter Programming in 8051**: Programming 8051 Timers, Counter programming, programming timers 0 and 1 using C/assembly language.	8
5	**8051 Serial Communication**: Basics of serial communication, 8051 connections to RS-232, 8051 serial communication programming. **Interrupts Programming:** 8051 Interrupts, programming timer interrupts, programming external hardware interrupts, programming the serial communication interrupts, interrupt priority in the 8051/52. **8051 Interfacing Applications**: Interfacing 8051 to LCD, keyboard, parallel and serial ADC, DAC, stepper motor interfacing, DC motor interfacing and PWM.	9

Course Outcome: At the end of the course students will be able to
CO1: Explain the architecture & difference between Microprocessor & Microcontrollers.
CO2: Use the arithmetic and logical instructions.
CO3: Use the instructions for writing assembly language and C program.
CO4: Use timers in Assembly Language and C program.
CO5: Use interrupts for serial and external peripherals interface.

TEXT BOOKS:

1. The 8051 Microcontroller Architecture, Programming & Applications, Kenneth J Ayla 2e, Penram International, 1996, Thomson Learning 2005.
2. The 8051 Microcontroller and Embedded Systems-Using Assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D McKinlay PHI/Pearson 2006.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 2 and 3 and questions 6 and 7 are to be from unit 2 and unit 5 respectively. Students have to answer Q.2 or Q.3 and Q.6 or Q.7.

3. Questions 1, 4 and 5 are to be set from units 1,3 and 4 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*		*	*					*
CO2	*	*	*	*		*	*					*
CO3	*	*	*	*		*	*					*
CO4	*	*	*	*		*	*					*
CO5	*	*	*	*		*	*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : CONTROL SYSTEMS		
Course Code : EE42	No. of Credits:4; L:T:P - 3:2:0	No. of hours/week: 3+2
Exam Duration: 3hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39+26

Course Objective:

1. To make the students aware of the basics of control system, its classification, the basic theory of Transfer Function, Impulse response and mathematical modeling for the overall analysis of the control system. Obtain transfer function using Block Diagram and Signal Flow Graph.
2. To make them understand the time response of feedback control systems and steady state errors.
3. Stability analysis is thought using various methods like Routh Hurwitz criterion, Root Locus and Bode Plot.

Unit No.	Syllabus Content	No. of Hours
1	a) **Modeling of Systems:** Introduction to control system, Mathematical models of physical systems – Introduction, Differential equations of physical systems. Mechanical systems – Translational and rotational systems (Mechanical accelerometer, Levered systems excluded), Electrical Analogous systems. P, PI and PID controllers. b) **Servomotor:** transfer functions, applications. c) **Block diagrams and signal flow graphs**: Transfer functions, Block diagram algebra, Signal Flow graphs (State variable formulation excluded)	9+6
2	**Time Response of feedback control systems:** Standard test signals, Unit step response of first and second order systems, Time response specifications, Time response specifications of second order systems, steady state errors and error constants.	8+5
3	a) **Stability analysis:** Concepts of stability, Necessary conditions for stability, Routh- stability criterion, Relative stability analysis. b) **Root Locus Techniques:** Introduction, root locus concepts, Construction of root loci and stability studies.	8+5
4	a) **Frequency domain analysis:** Introduction, Correlation between time and frequency response, bode plots, all pass and minimum phase systems, Assessment of relative stability using Bode Plots. b) Lag and lead compensators.	8+5
5	**Stability in the frequency domain:** Mathematical preliminaries, Nyquist stability criterion (Inverse polar plots excluded), Assessment of relative stability using Nyquist criterion (systems with transportation lag excluded).	6+5

Course Outcome: At the end of the course students will be able to -
CO1: Demonstrate an understanding of the fundamentals of control systems.
CO2: Apply the concepts to develop mathematical modeling and transfer function of any system using various techniques.
CO3: Analyze the control system with respect to system stability in time and frequency domain.

CO4: Analysis of system stability using graphical methods.

CO5: Design system using compensator for better performance.

TEXT BOOKS:

1. Control Systems Engineering, J. Nagarath and M.Gopal, New Age International (P) Limited, Publishers, First edition – 2008

REFERENCE BOOK/WEBSITE LINKS:

1. Modern Control Engineering, K. Ogata, Pearson Education Asia/ PHI, 4th Edition, 2002.
2. Concepts of Control Systems, P. S. Satyanarayana; Dynaram publishers, Bangalore, 2001
3. Control Systems – Principles and Design, M. Gopal, TMH, 1999.
4. Feedback Control System Analysis And Synthesis, J. J. D’Azzo and C. H. Houpis; McGraw Hill

---

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.
2: Questions 1 and 2 and questions 4 and 5 are to be from unit 1 and unit 3 respectively. Students have to answer Q.1 or Q.2 and Q.4 or Q.5.
3. Questions 3, 6 and 7 are to be set from units 2, 4 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*										*
CO2	*	*	*			*				*		*
CO3	*	*	*			*				*		*
CO4	*	*	*			*				*		*
CO5	*	*	*			*				*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : FIELD THEORY		
Course Code : EE43	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. To understand the basic concepts of electric and magnetic fields, the concept of Energy and Potential. Study of conductors, dielectrics, inductance and capacitance
2. To Study of Poisson and Laplace's equations and their applications.
3. To Study the Steady magnetic fields understand various Magnetic materials and forces. Boundary-value problems.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction to Electrostatics** **a. Coulomb's Law and electric field intensity**: Experimental law of Coulomb, electric field intensity, Types of charge distributions. Field due to various charge distributions-line charges, Surface charge, Volume charge. Fields due to infinite line charge, charged circular ring, infinite sheet charge. **b**. **Electric flux density, Gauss' law and divergence:** Electric flux and flux density, flux density for various charge distributions-Line charge, surface charge, volume charge. Gauss' law, divergence, Maxwell's first equation (Electrostatics), vector operator Δand divergence theorem.	12
2	a. **Energy and potential :** Energy expended in moving a point charge in an electric field, The line integral, definition of potential difference and Potential, The potential field of a point charge and system of charges, potential gradient, energy density in an electrostatic field. **b. Conductors and dielectrics:** Current and current density, Continuity of current, metallic conductors, conductor properties and boundary conditions, boundary conditions for perfect dielectrics.	10
3	**a. Poisson's and Laplace's equations:** Derivations of Poisson's and Laplace's equations. Examples of the solutions of Laplace's and Poisson's equations. **b. The steady magnetic field:** Biot-Savart law, Ampere's circuital law, Curl, Stokes' theorem, magnetic flux and flux density, scalar and Vector magnetic potentials.	10
4	**a. Magnetic forces and materials:** Force on a moving charge and differential current element, Force between differential current elements, Force and torque on a closed circuit. **b. Magnetic materials: Magnetization** and permeability, magnetic boundary conditions, magnetic circuit, potential energy and forces on magnetic materials.	10
5	**Time varying fields and Maxwell's equations**: Faraday's law, displacement current, general field relations for time varying electric and magnetic fields. Maxwell's equation in point and integral form.	10

Course Outcome: At the end of the course students will be able to -

CO1: Able to define and state the behavior of static electric fields in standard configurations.

CO2: Able to explain concepts of Energy and Potential to solve numerical problems.

CO3: Able to solve problems on Poisons and Laplace's equations, Biot-savarts law and Circuital laws.

CO4: Able to distinguish the behavior of Electrostatic and electromagnetic fields between two dielectrics/conductor-dielectric boundaries.

CO5: Able to apply Maxwell's equations for real time problems.

TEXT BOOKS:

1. Engineering Electromagnetics, William H Hayt Jr. and John A Buck, Tata McGraw-Hill, 7th edition, 2006.
2. Electromagnetics, J A Edminister Tata McGraw-Hill, Schaum's outlines, IInd Edition 2006

REFERENCE BOOK/WEBSITE LINKS:

1. Electromagnetic Waves And Radiating Systems, Edward C. Jordan and Keith G Balmain,Prentice – Hall of India / Pearson Education, 2nd edition, 1968.Reprint 2002
2. Field and Wave Electromagnetics, David K Cheng, Pearson Education Asia, 2nd edition, - 1989, Indian Reprint – 2001.
3. Electromagnetics with Applications, John Krauss and Daniel A Fleisch, McGraw-Hill, 5th edition, 1999.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 4 and 5 are to be from unit 1 and unit 3respectively. Students have to answer Q.1 or Q.2 and Q.4 or Q.5.

3. Questions 3, 6 and 7 are to be set from units 2, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*	*		*	*	*		
CO2			*	*	*					*		
CO3	*	*	*	*			*			*		
CO4	*	*	*	*			*			*		
CO5	*	*	*	*	*	*	*			*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : POWER ELECTRONICS-I		
Course Code : EE44	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week:3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:
1. Understand and acquire knowledge about various power semiconductor devices, characteristics and their applications.
2. Introduce different control techniques used in power electronics systems
3. Analyze different power converter circuits with an understanding of their switching behavior.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction to Power Semiconductor Devices:** Power semiconductor devices, control characteristics, types of power electronic circuits, and its peripheral effects. **Power Transistors:** Power BJT, MOSFET& IGBT- switching characteristics and isolation of control & power circuit.	06
2	**Thyristors:** Thyristor types, SCR structure – static & dynamic and characteristics, ratings, two transistor model, di/dt and dv/dt protection. Series and parallel operation of SCR. Simple design of firing circuits using UJT and digital ICs.	08
3	**Controlled Rectifiers:** Principle of phase controlled converter operation. Single-phase converters – half, semi and full converters with R & RL load.	09
4	**Commutation Techniques:** Natural Commutation. Forced commutation - self commutation, impulse commutation, resonant pulse commutation and complementary commutation. **DC Choppers:** Chopper classification, Performance parameters, control strategies, Principle of step-down and step-up chopper with R & R-L load.	08
5	**AC Voltage Controllers:** Principle of ON-OFF and phase control with R and RL load. Single-phase bidirectional controllers with resistive and inductive loads **Inverters:** Inverter classification**,** Principle of operation of basic half bridge inverter, Principle of operation of basic full bridge inverter, Performance parameters, Voltage control of single-phase inverters – single pulse width modulation, sinusoidal pulse width modulation.	08

Course Outcome: At the end of the course students will be able to -
CO1: Identify power electronic devices with their switching characteristics and selection of suitable device for applications.
CO2: Select analog or digital control circuit for SCR.
CO3: To decide converters for power conversion systems.

CO4: Analyze the performance of power conversion systems.
CO5: Evaluate the effects of modulation techniques on the quality of input and output waveforms.

TEXT BOOKS:

1. M.H.Rashid , Power Electronics,P.H.I. /Pearson, New Delhi, 2002, 2nd Edition
2. Ned Mohan, Tore M. Undeland, and William P. RobinsPower Electronics - Converters, Applications and Design, , John Wiley and Sons,, 3rd Edition
3. M.D. Singh and Khanchandani K.BPower Electronics,Tata.Mc.Hill., 2015

REFERENCE BOOK/WEBSITE LINKS:

1. G.K. Dubey, S.R. Doradla, A. Joshi and R.M.K. Sinha, Thyristorised Power Controllers, New Age International Publishers.
2. R.S. Ananda Murthy and V. Nattarasu, Power Electronics- A Simplified Approach,Sanguine Technical
Publishers,2013
3. J.M. Jacob Thomson, Power Electronics, Principles and Applications, Vikas Publications, 2010.
4. https://onlinecourses.nptel.ac.in

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.
2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.
3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*							*	
CO2	*		*	*	*							
CO3				*						*	*	*
CO4		*	*	*	*							*
CO5	*			*	*						*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : GENERATION, TRANSMISSION AND DISTRIBUTION		
Course Code : EE45	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To study various power generation techniques.
2. To study overhead and underground transmission systems.
3. To study the concepts of insulators, corona and distribution systems.
4. To study the calculation of inductance and capacitance of single phase and three phase lines.
5. To analyze the performance of power transmission lines.

Unit No.	Syllabus Content	No. of Hours
1	**Generation:** Sources of electrical power: General arrangement & working of nuclear, thermal and hydro power plant (block diagram approach only) , nuclear power plant - site selection, pros and cons, thermal power plant – site selection, pros and cons, hydro power plant – classification, site selection, pros and cons. **Introduction to typical transmission and distribution systems:** General layout of power system, Standard voltages for transmission, advantages and limitation of AC transmission system.	08
2	**Overhead Transmission Lines**: Types of supporting structures and line conducting materials used. Sag calculation- supports at same level and at different levels. Effect of wind and ice, Sag at erection, Stringing chart and sag templates. Line vibration dampers. **Underground Cables:** Types, material used, insulation resistance, charging current, grading of cables - capacitance grading & inter sheath grading, testing of cables.	10
3	**Insulators**: Introduction, materials used, classification, potential distribution over a string of suspension insulators. String efficiency & methods of increasing string efficiency - grading rings and arcing horns. Testing of insulators. **Distribution systems:** Requirements of power distribution, radial & ring main systems, AC and DC distribution - Calculation for concentrated loads and uniform loading, illustrative examples. **Corona:** Phenomena, disruptive and visual critical voltages, corona power loss, illustrative examples. Advantages and disadvantages of corona.	12
4	**Line parameters:** Calculation of inductance of single phase line, three phase line with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Capacitance of single phase line, three phase line with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines.	12
5	**Performance of Power Transmission Lines:** Short transmission lines, medium transmission lines- nominal T, end condenser and π models, long transmission lines, ABCD constants of transmission lines, Ferranti effect, line regulation.	10

Course Outcome: At the end of the course students will be able to -

CO1: Explain the construction and working of generating system, distribution system, insulators & underground cables.

CO2: Apply acquired knowledge & techniques to solve problems on transmission and distribution.

CO3: Analyze the performance of power transmission lines and distribution system.

CO4: Determine the necessary expressions for evaluating concepts of transmission and distribution

CO5: Discuss various concepts of overhead transmission lines.

TEXT BOOKS:

1.Electric Power Generation, Transmission and Distribution, S. M. Singh, PHI, 2nd Edition,2009

2. A Course in Electrical Power. Soni Gupta & Bhatnagar, Dhanpat Rai & Sons, 3rd edition, 2010.

3. Electrical Power Systems. C. L. Wadhwa, New Age International, 6th edition, 2010

REFERENCE BOOK/WEBSITE LINKS:

1. Elements of Power System Analysis. W.D. Stevenson, TMH, 4th Edition.
2. Electric power generation Transmission & Distribution. S. M. Singh, PHI, 2nd Edition, 2009.
3. Electrical Power. Dr. S. L. Uppal, Khanna Publications.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 2 and 3 and questions 6 and 7 are to be from unit 2 and unit 5 respectively. Students have to answer Q.2 or Q.3 and Q.6 or Q.7.

3. Questions 1, 4 and 5 are to be set from units 1, 3 and 4 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1		*										*
CO2	*		*	*		*						
CO3	*	*	*		*	*						
CO4	*	*	*		*	*						
CO5	*		*		*	*						

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : MICROCONTROLLER LAB		
Course Code : EEL46	No. of Credits:1.5; L:T:P - 0:0:1.5	No. of hours/week:3
Exam Duration: 3 hrs.	CIE + SEE = 50+ 50 = 100 Marks	

Course Objective:

1. To provide a practical introduction to microcontrollers assembly language & embedded C programming techniques, hardware interfacing circuit.

Unit No.	Syllabus Content	No. of Hours
	I. PROGRAMMING:	3
1	Data Transfer - Block move, Exchange, Sorting, Finding largest element in an array.	3
2	Arithmetic Instructions - Addition/subtraction, multiplication and division, square, Cube – (16 bits Arithmetic operations – bit addressable).	3
3	Counters.	3
4	Boolean & Logical Instructions (Bit manipulations).	3
5	Conditional CALL & RETURN.	3
6	Code conversion: BCD – ASCII; ASCII – Decimal; Decimal - ASCII; HEX - Decimal and Decimal - HEX.	3
7	Programs to generate delay, Programs using serial port and on-Chip timer / counter.	3
	II. INTERFACING 8051 CHIP USING C PROGRAMS	
8	Simple Calculator using 6 digit seven segment display and Hex Keyboard.	3
9	Alphanumeric LCD panel and Hex keypad input.	3
10	External ADC and Temperature control.	3
11	Generation of different waveforms - Sine, Square, Triangular, Ramp etc. using DAC; changing the frequency and amplitude.	3
12	Stepper and DC motor control.	3
13	Elevators.	

Course Outcome: At the end of the course students will be able to -
CO1: Understand different instruction set and architecture of 8051 Microcontroller.
CO2: Write & Analyze assembly language programming.
CO3: Understand usage of directives, Code Memory & external memory.
CO4: Write assembly language program using bit instructions.
CO5: Build Interfacing Circuit using embedded C programming.

TEXTBOOK:

1. The 8051 Microcontroller Architecture, Programming & Applications, Kenneth J Ayla 2e, Penram International, 1996, Thomson Learning 2005.
2. The 8051 Microcontroller and Embedded Systems-Using Assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D McKinlay PHI/Pearson 2006.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*		*	*					*
CO2	*	*	*	*		*	*					*
CO3	*	*	*	*		*	*					*
CO4	*	*	*	*		*	*					*
CO5	*	*	*	*		*	*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : TRANSFORMERS AND INDUCTION MACHINES LAB		
Course Code : EEL47	No. of Credits:1.5; L:T:P - 0:0:1.5	No. of hours/week:3
Exam Duration: 3 hrs.	CIE + SEE = 50+ 50 = 100 Marks	

Course Objective:

1. To introduce various tests on Transformer, poly-phase Induction Machines and single-phase Induction Motor and evaluation of their performance.
2. To verify the parallel operation of two dissimilar transformers load sharing.
3. To learn various methods of speed control of Induction motor.
4. To study the connection of single phase transformers for three phase operation and phase conversion.

Unit No.	Syllabus Content	No. of Hours
1	(a) Predetermination of efficiency and regulation by Open Circuit and Short circuit tests on single - phase transformer. (b) Calculation of equivalent circuit parameters from the test data and determination of efficiency, Regulation from the equivalent circuit to correlate results obtained earlier.	3
2	Sumpner's test on similar transformers and determination of combined and individual transformer efficiency	3
3	Parallel operation of two dissimilar (different kVA) single-phase transformers and determination of load sharing and analytical verification given the Open Circuit and Short circuit tests details.	3
4	Polarity test and connection of 3 single-phase transformers in star – delta and determination of efficiency under balanced and unbalanced resistive load.	3
5	Scott connection with balanced and unbalanced resistive loads.	3
6	Load test on 3-phase induction motor and determination of performance characteristics.	3
7	(a) NO load and Blocked rotor tests on 3-phase induction Motor Predetermination of performance from the Circle diagram. (b) Determination of parameters of the equivalent circuit of a 3-phase Induction Motor and correlate the results obtained from the circle diagram.	3
8	Speed control of 3-phase induction motor by varying rotor resistance.	3
9	Load test on- induction generator.	
10	Load test on single- phase induction motor.	3

Course Outcome: At the end of the course students will be able to -

CO1: Conduct various tests on single-phase transformer, and evaluate their performance

CO2: Poly-phase induction machines and single-phase induction motor and evaluate their performance

CO3: Operate two dissimilar transformers in parallel for different load sharing.

CO4: Experiment the various methods of speed control of Induction motor.

CO5: Examine the connection of single phase transformers for three phase operation and phase conversion.

REFERENCE: Laboratory manual

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*				*			*	*	*	*	
CO2	*				*			*	*	*	*	
CO3	*			*	*				*	*	*	
CO4	*			*	*				*	*	*	
CO5	*				*							

DR.AMBEDKAR INSTITUTE OF TECHNOLOGY, BANGALORE

(An Autonomous Institution Affiliated To VTU, Belgaum)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

V SEMESTER B.E, ACADEMIC YEAR (2018-19)

Batch – 2016

CODE NO.	COURSE	CONTACT HOURS/WEEK			CREDITS	MAXIMUM MARKS		
		LECTURE	TUTORIAL	LAB		CONTINUOUS INTERNAL EVALUATION	SEMESTER END EVALUATIO N	TOTAL
HS03	Management And Entrepreneurship	4	0	0	4	50	50	100
EE51	Signal & Systems	2	2	0	3	50	50	100
EE52	Power Electronics-II	3	0	0	3	50	50	100
EE53	DC Machines & Synchronous Machines	4	0	0	4	50	50	100
EE54x	Elective - A	3	0	0	3	50	50	100
EE55x	Elective - B	4	0	0	4	50	50	100
EEL56	Control Systems Lab	0	0	3	1.5	50	50	100
EEL57	Power Electronics Lab	0	0	3	1.5	50	50	100
EEL58	Simulation Lab	0	0	2	1	50	50	100
TOTAL		21	2	6	25	450	450	900

Elective- Group A (3 credits each)		**Elective- Group B (4credits each)**	
EE541	Advanced Instrumentation System	EE551	VLSI Circuits & Design
EE542	Embedded Systems	EE552	Operating System
EE543	Modern Control Theory	EE553	Linear IC's and Applications

Inter Department Electives : Students who have not completed the IDE should register for the completion of 200 credits. According to section 16.2, Academic Regulations of Dr AIT, the credits registered should not exceed 30.

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : POWER ELECTRONICS -II		
Course Code : EE52	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. Understand the speed control and braking methods of electrical drives for day to day applications.

2. Analyze the performance of converter fed DC and Induction motors along with speed torque characteristics.

3. Explain various speed - torque control techniques for industrial applications.

4. Design the modeling of drives in open loop and closed loop condition to justify their applications.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction: C**oncept of electrical drives, classification **Dynamics of Electrical Drives:** Types of loads, quadrantal diagram of speed-torque characteristics, Load torques that vary with angle of displacement and time, dynamics of motor-load combination, Determination of Moment of inertia, Steady state stability of an Electric drive, Transient stability of an Electric Drive	**9**
2	**Starting :** Effect of starting power supply, motor and load, methods of starting electric motors, energy relations during starting, methods to reduce the energy loss during starting	**7**
3	**Braking :** Types, braking of dc motors during lowering of loads, braking of induction motors and induction motors, energy relations during braking, dynamics of braking	**9**
4	**Introduction to solid state controlled drives :** DC Motor systems, AC motor systems, brushless dc motors, switched reluctance motors, stepper motor	**7**
5	**Industrial Applications** Steel mills, paper mills, cement mills, textile mills, electric traction, coal mining.	**7**

Course Outcome: At the end of the course students will be able to -
CO1: Understand the dynamics of Electrical Drives
CO2: State and understand the starting methods of electric drives for day today applications
CO3: State and understand the braking methods of electric drives for day today applications
CO4: Understand the types of motors involved in solid state controlled drives
CO5: Analyze the types of motors in industrial applications

TEXT BOOKS:

1. S. K Pillai, A First course on Electrical Drives , New age international publishers
2. G K Dubey, Fundamentals of electric drives , Narosa Publications,1995
3. M.D. Singh and Khanchandani K.B Power Electronics, Tata.Mc.Hill. 2012.
4. M.H.Rashid, Power Electronics, P.H.I. /Pearson, New Delhi, 2002, 2^{nd} Edition.

REFERENCE BOOK/WEBSITE LINKS:

1. Ned Mohan, Tore M. Undeland, and William P. Robins, Power Electronics - Converters, Applications and Design, John Wiley and Sons, .Third Edition,
2. G.K. Dubey, Power Semi-conductor drives.
3. R Krishnan, Electric motor drives – Modelling, Analysis and Control, Pearson.
4. Shepherd Hulley, Power Electronics and Motor control ,Cambridge University Press,2^{nd} Edition,
5. P C Krause, Analysis of Electric machinery and drive systems,IEEE presses, 2^{nd}Edition,

INSTRUCTIONS TO PAPER SETTERS

1. Students have to answer five questions each of 20 marks.
2. Question Nos. 3, 6 and 7 are compulsory and are from units 2, 4 and 5.
3. Question Nos. 1 & 2, 4 & 5are from units 1and 3 respectively. Students have to answer one from questions 1 & 2 and one from questions 4 & 5.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*								
CO2	*		*	*							*	
CO3			*	*	*							
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : DC Machines and Synchronous Machines		
Course Code : EE53	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To gain knowledge on construction and working of DC machines and synchronous machines.
2. To study characteristics of DC machines and synchronous machines
3. To study various methods of testing, losses and efficiency of DC machines.
4. To analyze various methods of determining voltage regulation of a synchronous generator.
5. To analyze the operation of a synchronous machine (both as a generator and motor).

Unit No.	Syllabus Content	No. of Hours
1	**DC generator**: Review of basics of DC machines, classification of DC generator, types of armature winding, emf equation, no-load characteristic, armature reaction, load characteristics. Commutation, types of commutation, commutation difficulties, interpoles, compensating winding and equalizer rings (only qualitative treatment). Classification of DC motors, back emf and its significance, torque equation, characteristics of shunt, series & compound motors, speed control of shunt and series motors. Application of DC motors.	10
2	**Losses and efficiency:** losses in dc machines, power flow diagram, efficiency, condition for maximum efficiency. **Testing of dc machines**: direct & indirect methods of testing of dc machines-brake test, swine burn's test, Hopkinson's test, retardation test, field's test, merits and demerits of tests.	10
3	**Synchronous machines:** Basic principle of operation, construction of salient & non-salient pole synchronous machines, generated EMF, effect of distribution and chording of winding, harmonics-causes, reduction and elimination. Armature reaction, synchronous reactance, leakage reactance, phasor diagram of non-salient type alternator.	10
4	**Voltage Regulation**: Voltage regulation by EMF, MMF, ZPF & ASA method. Short circuit ratio and its importance. Two reaction theory-direct and quadrature axis reactances, phasor diagram. Slip test and regulation. Synchronizing to infinite bus bars, parallel operation of alternators. Operating characteristics, power angle characteristics excluding armature resistance, operation for fixed input and variable excitation.	12
5	**Synchronous motor:** Principle of operation, phasor diagrams, torque and torque angle, Blondel diagram, effect of change in load, effect of	10

	change in excitation, ‘V’ and ‘inverted V curves’. Synchronous condenser, hunting and damping. Methods of starting of synchronous motors. **Special DC motors**: Permanent magnet motors, brushless DC motors. Applications.	

Course Outcome: At the end of the course students will be able to -

CO1. Explain constructional features and phenomena related to DC, synchronous machines and special machines. (L1)

CO2. Explain the operation, characteristics and performance to DC, synchronous machines and special machines. (L2)

CO3. Solve problems related to speed control, losses and efficiency of DC machines.(L3)

CO4. Analyze the behavior of synchronous machines in parallel and on infinite busbars.(L4)

CO5. Evaluate voltage regulation of synchronous generators by various methods. (L5)

TEXT BOOKS:

1. Electrical Machinery:DP Kothari, I.J.Nagarath, TMH, 4^{th} edition, 2010.
2.Electrical Machines:P.S Bhimbra, Khanna Publishers
3. Electric Machines: Mulukuntla.S.Sarma, Mukesh.K.Pathak, Cengage Learning, First edition, 2009.
4. Electric Machines: AhhijitChakrabarti, SudiptaBebnath, McGraw Hill Education (India) Private Limited, New Delhi.

REFERENCE BOOK/WEBSITE LINKS:

1. Performance& Design of Alternating Current machines**:** M. G. Say, CBS publishers, 3rd Edition, 2002.
2. The Performance & Design of DC machines:A.E Clayton &N.N.Hancock CBS Publication, 3^{rd} Edition, 2004.
3. Electrical Machines: AshfaqHussain, DhanpatRai Publications.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.
2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.
3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*		*					*
CO2	*	*	*	*	*		*					*
CO3	*	*	*	*	*		*					*
CO4	*	*	*	*	*		*					*
CO5	*	*	*	*	*		*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : CONTROL SYSTEMS LAB		
Course Code : EEL56	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

1. To study Transient and steady state behavior of linear control systems, study frequency and Time domain response characteristics of 2^{nd} order systems.
2. To design compensating networks for improvement of stability, study AC/DC servomotor performance.

Unit No.	Syllabus Content
1	Simulation of a typical second order system and determination of step response and evaluation of time- domain specifications using a software tool
2	(a) Design of a passive RC lead compensating network for the given specifications, viz., the maximum phase lead and the frequency at which it occurs and to obtain its frequency response. (b) Experimental determination of transfer functions of a lead compensating network.
3	(a) Design of a RC lag compensating network for the given specifications. viz., the maximum phase lag and the frequency at which it occurs, and to obtain its frequency response. (b) Experimental determination of transfer functions of a lag compensating network.
4	Study of the effect of P, PI, PD and PID controller on the step response of a feedback control system (using control engineering trainer/process control simulator).
5	Speed – torque characteristic of a two - phase A.C. servomotor.
6	Speed torque characteristic of a D.C. servomotor.
7	Experimental determination of frequency response of a second -order system and evaluation of frequency domain specifications
8	Simulation of a D. C. position control system and its step response.
9	Determination of phase margin and gain margin of a transfer function by Bode Plots and verification by simulation.
10	Construction of root locus of transfer function and verification by simulation.
11	Synchro pair characteristics.

Course Outcome: At the end of the course students will be able to -
CO1: Understand and analyze the time and frequency domain specifications for a second order system.
CO2:Analyze the performance of servomotors.
CO3: Evaluating system performance using P,I,D controllers
CO4: Design the control system with compensators.
CO5: Use MATLAB for simulation and validation of results obtained by analytical calculations.

REFERENCES:
1.Matlab user manual, Ogata
2.Matlab by Rudrapratap

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*	*	*			*	*		*
CO2	*	*	*	*	*	*			*	*		*
CO3	*	*	*	*	*	*			*	*		*
CO4	*	*	*	*	*	*			*	*		*
CO5	*	*	*	*	*	*			*	*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : POWER ELECTRONICS LAB		
Course Code : EEL57	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

1. To learn observe the characteristics of Power semiconductor devices practically.
2. To implement the controllable switches in different power electronic converter circuits for applications such as speed control of electrical machines and practical loads.

Unit No.	Syllabus Content
	Introduction to laboratory and data sheets of devices
1	Static characteristics of SCR.
2	Static characteristics of MOSFET and IGBT.
3	SCR turn-on circuit using UJT relaxation oscillator.
4	SCR Digital triggering circuit for single phase controlled rectifier.
5	Single-phase full-wave rectifier with *R* and *R-L* loads, with and without freewheeling diode
6	A.C. voltage controller using TRIAC – DIAC/UJT combination connected to *R* load
7	Speed control of a stepper motor.
8	Speed control of a universal motor / single-phase induction motor using A.C. voltage
9	Speed control of a separately excited D.C. motor using an IGBT/ MOSFET chopper.
10	MOSFET /IGBT based single-phase full-bridge inverter connected to R load.
11	Simulate the dynamic characteristics of (i) MOSFET (ii) IGBT (iii) BJT *
12	For given dv/dt ratings, design a snubber circuit and observe the response of the circuit by* simulation
13	Study the performance of SCR forced commutating circuits.— (i) By reducing the forward current below the holding current (current commutation) (ii) By applying a large reverse voltage across conducting SCR (Voltage commutation) *
	* - Experiments beyond syllabus

Course Outcome: The student will have,
CO1. An ability to understand basic operation of various power semiconductor devices and passive components.
CO2. An ability to understand the basic principle of switching circuits.
CO3. An ability to analyze and design an AC/DC rectifier circuit.
CO4. An ability to analyze and design DC/DC converter circuits.
CO5. An ability to analyze DC/AC inverter circuit.

REFERENCES:

1. **Power Electronics,** M.H.Rashid, 2nd Edition, P.H.I. /Pearson, New Delhi, 2002.
2. **Power Electronics – Converters, Applications and Design**, Ned Mohan, Tore M. Undeland, and William P. Robins,Third Edition, John Wiley and Sons.
3. **Laboratory Manual**

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*		*			*	*		*
CO2		*	*	*	*					*		
CO3	*		*		*	*			*			
CO4		*		*		*				*		
CO5	*	*	*	*	*	*			*	*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : SIMULATION LAB		
Course Code : EEL58	No. of Credits:1; L:T:P -0:0:1	No. of hours/week: 2
Exam Duration: 3 hrs.	CIE + SEE =+ 50 = 100 Marks	

Course Objective:

1. To simulate different analog, digital and power electronics circuits.
2. To implement the circuits used for measurement using software package.

Unit No.	Syllabus Content
1	a) Inverting, non-inverting & scale changing of signals using op-amps b) RC phase shift oscillator using op amps (Both using Pspice package)
2	RC coupled amplifier-frequency response for variation in bias & coupling using Pspice simulation package
3	Rectifier circuits-Bridge rectifier, diode clipping & clamping circuits using Pspice simulation package.
4	Schmitt –trigger- inverting and non-inverting using Pspice simulation package.
5	Signal generator- triangular, saw tooth and rectangular wave generation using Pspice simulation package.
6	Simulation of Thevinin's theorem using Pspice simulation package.
7	Simulation of Super-position theorem using Pspice simulation package.
8	Simulation of Encoder using Pspice simulation package.
9	Simulation of Decoder using Pspice simulation package.
10	Simulation of MUX using Pspice simulation package.
11	Simulation of DEMUX using Pspice simulation package.
12	Simulation of 3- phase controlled rectifier using MATLAB
13	Simulation of 3- phase un-controlled rectifier using MATLAB

Course Outcome: At the end of the course students will be able to -

CO1: understand the importance of simulation studies with respect to digital circuits.

CO2: Learn the importance of simulation studies with respect to analog circuits.

CO3: To perform simulation studies with respect to power electronic circuits.

CO4: To analyze electrical circuits using simulation software.
CO5: Design circuits using MATLAB and PSPICE software for simulation.

REFERENCES:

1. Laboratory manual
2. PSpice User Manual
3. MATLAB user manual.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*	*			*	*		*
CO2	*	*	*	*	*	*			*	*		*
CO3	*		*						*	*		*
CO4		*		*	*				*	*		
CO5	*	*	*	*	*				*	*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : ADVANCED INSTRUMENTATION SYSTEM		
Course Code : EE541	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. To expose Instrumentation, as a Technology of measurement.
2. To study various Measurement Techniques measuring instruments.
3. To study the construction and working of various Transducers.
4. To study the design and applications of Data Acquisition systems.
5. To understand some standard data Transmission systems.

Unit No.	Syllabus Content	No. of Hours
1	**Instrumentation:** Frequency Meter, Measurement of Time and Frequency (Mains), Tachometer, Phase Meter, Capacitance Meter. Automation in Digital Instrumentation.	07
2	**Measuring Instruments:** Output Power Meters, Field Strength Meter Vector Impedance Meter, Q Meter Applications-Z, Z_0 And Q. Basic LCR Bridge, RX Meters**.**	10
3	**Transducers:** Synchronous, Capacitance Transducers, Load Cells, Piezo Electrical Transducers, IC Type Temperature Sensors, Pyrometers, Ultrasonic Temperature Transducer, Reluctance Pulse Pick-Ups.	10
4	**Data Acquisition And Conversion:** Generalized Data Acquisition System (DAS), Signal Conditioning of Inputs, Single Channel DAS, Multi-Channel DAS, Data Loggers, Compact Data Logger.	07
5	**Data Transmission:** RS-232 Standard, Universal Serial Bus, IEEE-1394.Long Distance Data Transmission (Modems).IEEE 488 Bus. Electrical Interface.	05

Course Outcome: At the end of the course students will be able to -

CO1: To study the principle, construction and working of digital instruments and understand the use of automation in digital instrumentation, harmonic and wave analyzers.

CO2: To understand the telemetry systems and get brief insight of various transmission methods used in Industry.

CO3: To understand transducers for usable output (analog, digital or frequency modulated) in response to specified input measurands (Physical/mechanical etc.).

CO4: Understand data acquisition systems and measurement of power at RF and microwave frequencies.

CO5:Understand the instruments that exist in remote places and transmit over long distances to a master control room

TEXT BOOKS:

1. Electronic Instrumentation. H S Kalsi, TMH, 3rd Edition, 2010**.**

2. Modern Electronic Instrumentation and Measuring Techniques. Cooper D and A D Helfrick, PHI, 2009

3. Student Reference Manual for Electronic Instrumentation Laboratories. Stanly Wolf, Richard F H, Smith, PHI, 2nd Edition, 2010

REFERENCE BOOK/WEBSITE LINKS:

1. Instrumentation reference book. Fourth edition, Walt boyes , Elsevier publishes 2010
2. Student Reference Manual for Electronic Instrumentation Laboratories.
Stanly Wolf, Richard F H, Smith, PHI, 2nd Edition, 2010
3. http://www.unb.ca/cel/online/courses-programs/open-entry/engineering-ee6913.html
4. Spectrum.ieee.org

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 2and 3 and questions 4 and 5 are to be from unit 2 and unit 3 respectively. Students have to answer Q.2 or Q.3 and Q.4 or Q.5.

3. Questions 1, 6 and 7are to be set from units 1, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*			*				*	*		
CO2	*	*			*				*			*
CO3	*				*	*	*			*		*
CO4	*	*	*			*		*			*	*
CO5						*	*	*			*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : EMBEDDED SYSTEMS		
Course Code : EE542	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. Understand embedded system and real time systems.
2. Real-time systems: Identify the unique characteristic, explain general structure and define the unique design problems and challenges of real-time system
3. Understand basics, program, design, implement and test an embedded system.

Unit No.	Syllabus Content	No. of Hours
1	**Concept of Embedded System Design:** Components, classification, skills required. Embedded Micro controller cores, Architecture of 6808 and 6811. Embedded Memories ROM variants and RAM. Applications of embedded system: Examples of Embedded systems.	07
2	**Technological Aspects of Embedded System:** Interfacing between analog and digital blocks, Signal conditioning, digital signal processing, DAC & ADC interfacing, Signal conditioning using DSP.	09
3	**Design Trade Offs Due to Process Incompatibility, Thermal Considerations:** Issues in embedded system design. Design challenge, design technology, tradeoffs. Thermal considerations.	07
4	**Software Aspects of Embedded Systems**: Real time programming languages, operating systems. Programming concepts and embedded programming in C. Round Robin, Round Robin with interrupts, Real time OS architecture, Selecting architecture. Introduction to RTOS.	09
5	**Subsystem Interfacing**: External system, user interfacing and Serial I/O devices, Parallel port interfaces: Input switches, Key boards and Memory interfacing. **Case Study:** Embedded velocity PID controller, PI controller with a PWM actuator.	07

Course Outcome: At the end of the course students will be able to -

CO1: To learn the concept of embedded microcontroller cores, architecture and application of embedded system.

CO2: To understand technological aspects of interfacing between analog and digital blocks.

CO3: Embedded system design issues in compatibility are to be understood.

CO4: To learn the method of designing a real time system.

CO5: To learn the technological hardware of embedded system aspects.

TEXT BOOKS:

1. Embedded Microcomputer systems: Real time interfacing. Valvano, J.W, Cengage Learning, 2nd Edition 5th Indian reprint,2009
2. The Art of Designing Embedded Systems. Ganssle, Jack, Newness
3. Embedded System, Architecture, Programming and Design. Raj Kamal, TMH, 2nd Edition 2008.

REFERENCE BOOK/WEBSITE LINKS:

1A Unified Hardware/Software Introduction. Frank Vahid/Tony Givargis, Wiley student edition 2002

2Motorola and Intel Manuals

3Embedded Software Premier. Simon David, Addison Wessly 2000

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 2 and 3 and questions 5 and 6 are to be from unit 2 and unit 4 respectively. Students have to answer Q.2 or Q.3 and Q.5 or Q.6.

3. Questions 1, 4 and 7 are to be set from units 1, 3 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*										
CO2			*	*	*							
CO3					*		*					
CO4									*	*		
CO5											*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : MODERN CONTROL THEORY		
Course Code : EE543	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:
1. Students would be able to design and analyze the system in industrial control.
2. Student will get familiar with advanced applications of control system.

Unit No.	Syllabus Content	No. of Hours
1	**State Variable Analysis And Design**: Introduction, concept of state, state variables and state model, state modeling of linear systems, linearization of state equations. State space representation using physical variables, phase variables & canonical variables.	8
2	**Derivation of transfer function from state model**, Diagonalization, Eigen values, Eigen vectors, generalized Eigen vectors. Solution of state equation, state transition matrix and its properties, computation using Laplace transformation.	8
3	**Concept of controllability & observability**, methods of determining the same, effect of pole zero cancellation, duality.	7
4	**Pole Placement Techniques**: stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design.	8
5	**Non-linear systems**: Introduction, behavior of non-linear system, common physical non linearity-saturation, friction, backlash, dead zone, relay, multi variable non-linearity. Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories.	8

Course Outcome: At the end of the course students will be able to -

CO1: Understand the fundamentals of state variables, linear and nonlinear systems.

CO2: Analyze SISO and MIMO systems and obtain the state models.

CO3: Application of Eigen values for derivation of transfer functions.

CO4: Perform analysis on Controllability and Observability.

CO5: Improve stability of a given system by state feedback pole placement techniques

TEXT BOOKS:

1. Digital control & state variable methods. M. Gopal , 3rd Edition, TMH ,2008
2. Control system Engineering. I. J. Nagarath& M. Gopal, New Age International (P) Ltd, 3rd edition.

REFERENCE BOOK/WEBSITE LINKS:

1. State Space Analysis of Control Systems**.** Katsuhiko Ogata -PHI
2. Automatic Control Systems**.** Benjamin C. Kuo&FaridGolnaraghi, 8th edition, John Wiley & Sons 2009.
3. Modern Control Engineering. Katsuhiko Ogata, PHI,5th Edition, 2010
4. Modern Control Engineering. D. Roy Choudary, PHI, 4th Reprint, 2009.
5. Modern control systems. Dorf& Bishop- Pearson education, 11th Edition 2008

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 2 and 3 and questions 6 and 7 are to be from unit 2and unit 5 respectively. Students have to answer Q.2 or Q.3 and Q.6 or Q.7.

3. Questions 1, 4 and 5 are to be set from units 1, 3 and 4 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*								*		*
CO2	*	*				*				*		*
CO3	*	*				*				*		*
CO4	*	*				*				*		*
CO5	*	*				*				*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : VLSI CIRCUIT DESIGN		
Course Code : EE551	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To introduce the present technology applied in the MOS Fabrication and to design and analyze the basic electrical properties of various transistors and its electrical equivalent models
2. To teach the students regarding the classical representations of the various transistors and to enable the electrical engineers to calculate the circuit parameters involved in the scaling process.
3. Issues arising during the architectural and structural design of a basic sequential and clocked circuit is discussed

Unit No.	Syllabus Content	No. of Hours
1	**A Review Of Microelectronics And An Introduction To MOS Technology:** Introduction To Integrated Circuit Technology. Introduction, VLSI Technologies, MOS Transistors, Fabrication, Thermal Aspects, Production Of E-Beam Masks.	10
2	**Basic Electrical Properties Of MOS And BICMOS Circuit:** Drain To Source Current I_{ds} Versus V_{ds} Relationships- BICMOS Latch Up Susceptibility. MOS Transistor Characteristics, Figure Of Merit, Pass Transistor NMOS And CMOS Inverters, Circuit Model, Latch Up In CMOS Circuits.	11
3	**MOS And BICMOS Circuit Design Processes:** MOS Layers, Stick Diagrams, Design, Symbolic Diagrams. **Basic Circuit Concepts And Scaling Of MOS Circuits:** Sheet Resistance, Capacitance Layer Inverter Delays, Wiring Capacitance, Choice Of Layers. Scaling Model And Scaling Factors- Limitations Due To Current Density.	11
4	**Subsystem Design And Layout:** Architectural Issues, Systems Considerations. Examples Of Structural Design, Clocked Sequential Circuits.	10
5	**Subsystem Design Processes: G**eneral Considerations, Illustration Of Design Process, Observations. **Illustration Of The Design Process:** Observation On The Design Process, Regularity Design Of An ALU Subsystem. Design Of 4-Bit Adder, Implementation Of ALU Functions.	10

Course Outcome: At the end of the course students will be able to -

CO1: Students will be aware of the present MOS technology.

CO2: Understand different properties of MOS and BICMOS circuits.

CO3: Understand the design process of MOS and BICMOS circuits along with scaling of MOS circuits.

CO4: To understand subsystem design and layout.

CO5: To understand the process of subsystem design.

TEXT BOOKS:

1. Basic VLSI Design. Douglas Pucknell & Eshragian, PHI, 3rd Edition, 2009.
2. Fundamentals of Modern VLSI Devices. Yuan TaunTak H Ning Cambridge Press, South Asia Edition 2003,
3. Modern VLSI Design. Wayne wolf, Pearson Education Inc. 3rd edition, 2003.
4. Introduction to CMOS VLSI Design-A Circuits and Systems Perspective. Neil Weste, Pearson Education. 3rd Edition.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 3 and 4 and questions 5 and 6 are to be from unit 3 and unit 4 respectively. Students have to answer Q3 or Q.4 and Q.5 or Q.6.

3. Questions 1, 2 and 7 are to be set from units 1, 2 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*	*					*		*
CO2	*	*	*	*	*					*		*
CO3	*	*	*	*	*					*		*
CO4	*	*	*	*	*					*		*
CO5	*	*	*	*	*					*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : OPERATING SYSTEMS		
Course Code : EE552	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To make the students understand about the computer organizations including its subsidiary systems, the concept of system management with various process controls methods.
2. To explain the students about the need of synchronization and to overcome the deadlocks and to familiarize the use of various memory and their Accessibility in the operating system operations.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction To Operating System, System Structures:** What Operating System Do; Computer System Organization; Computer System Architecture; Operating System Structure; Operating System Operations; Process Management; Memory Management; Storage Management; Protection And Security; Distributed System; Special Purpose Systems; Computing Environments. Operating System Services; User - Operating System Interface; System Calls; Types Of System Calls; System Programs; Operating System Design And Implementation; Operating System Structure; Virtual Machines; Operating System Generation; System Boot.	11
2	**Process Management:** Process Concept; Process Scheduling; Operations On Processes; Inter-Process Communication. Multi-Threaded Programming: Overview; Multithreading Models; Thread Libraries; Threading Issues. Process Scheduling: Basic Concepts; Scheduling Criteria; Scheduling Algorithms; Multiple-Processor Scheduling; Thread Scheduling.	10
3	**Process Synchronization:** Synchronization: The Critical Section Problem; Peterson's Solution; Synchronization Hardware; Semaphores; Classical Problems Of Synchronization; Monitors. **Deadlocks:** Deadlocks: System Model; Deadlock Characterization; Methods For Handling Deadlocks; Deadlock Prevention; Deadlock Avoidance; Deadlock Detection And Recovery From Deadlock.	10
4	**Memory Management:** Memory Management Strategies: Background; Swapping; Contiguous Memory Allocation; Paging; Structure Of Page Table; Segmentation. Virtual Memory Management: Background; Demand Paging; Copy-On-Write; Page Replacement; Allocation Of Frames; Thrashing. **File System, Implementation Of File System:** File System: File Concept; Access Methods; Directory Structure; File System Mounting; File Sharing; Protection. Implementing File System: File System Structure; File System Implementation; Directory Implementation; Allocation Methods; Free Space Management.	11

5	**Secondary Storage Structures, Protection:** Mass Storage Structures; Disk Structure; Disk Attachment; Disk Scheduling; Disk Management; Swap Space Management. Protection: Goals Of Protection, Principles Of Protection, Domain Of Protection, Access Matrix, Implementation Of Access Matrix, Access Control, Revocation Of Access Rights, Capability-Based Systems.	10

Course Outcome: At the end of the course students will be able to –

CO1: Explain about the basic operations and the phenomena involved in operating of operating systems.

CO2: Explain the working of various processes and the concept of multi-tasking.

CO3: Define the synchronization requirements and its importance during the operation

CO4: Justify the allocation of the memory for various tasks and its management

CO5: List out the importance of the need of secondary memory and to protect the basic OS principles.

TEXT BOOKS:

1. Operating System Principles. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Wiley, 8th Edition, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. Operating Systems: A Concept Based Approach. D.M Dhamdhere, TMH, 2nd Edition, 2006.

2. Operating Systems. P.C.P. Bhatt, PHI, 2nd Edition, 2008.

3. Operating Systems. Harvey M Deital, Pearson Education, 3rd Edition.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 2 and 3 and questions 5 and 6 are to be from unit 2 and unit 4 respectively. Students have to answer Q.2 or Q.3 and Q.5 or Q.6.

3. Questions 1, 4 and 7 are to be set from units 1, 3 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*					*		*
CO2	*	*	*	*	*					*		*
CO3	*	*	*	*	*					*		*
CO4	*	*	*	*	*					*		*
CO5	*	*	*	*	*					*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : LINEAR ICS AND APPLICATIONS		
Course Code : EE553	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. To acquaint the students with the basic characteristic and operation of op-amp and frequency response of op-amp.
2. To enable students to apply op-amp in AC amplifier circuits.
3. To design & analyze different linear, non-linear & mathematical application circuits using op-amp.
4. To learn some special applications of op-amps in integrated circuits.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction:** Operational amplifier description-–Circuit symbol and terminals, block diagram. Basic op-amp parameters- Input and output voltage range, offset voltage and current, offset nulling, CMRR, PSRR, input and output impedance, slew rate **(no question shall be set from the introduction)** **OP-Amps as AC Amplifiers:** Capacitor-Coupled voltage follower, High Z_{in} Capacitor Coupled voltage follower, Capacitor-Coupled non-inverting amplifier, High Z_{in} Capacitor Coupled non-inverting amplifier, Capacitor-Coupled inverting amplifier, setting upper cut off frequency, use of single polarity supply. **OP-Amp Frequency Response And Compensation:** Op-amp circuit stability, frequency and phase response, frequency compensating methods, manufacturer's recommended compensation, slew rate effects, stray capacitance effects, load capacitance effects, Z_{in} mode compensation, circuit stability precautions.	12
2	**Signal Processing Circuits:** Introduction, saturating precision half wave rectifier, non-saturating half wave precision rectifier, two output precision half wave rectifier, precision full wave rectifier using half wave rectifier and summing circuit, high input impedance full wave precision rectifier, peak clipper, dead zone circuit, precision clipper, precision clamping circuit, precision rectifier peak detector, voltage follower peak detector, sample and hold circuit.	10
3	**OP-Amp Nonlinear Circuits:** Op-amps in switching circuits, zero crossing detectors, Inverting & Non inverting Schmitt trigger circuits, Astable multivibrator and monostable multivibrator. **Signal Generators:** Triangular wave generator, rectangular wave generator, phase shift oscillator, Wien bridge oscillator.	10
4	**Active Filters:** First order low pass active filter, second order low pass active filter, first order high pass active filter, second order high pass active filter, band pass filter, band stop filter.	10
5	**DC Voltage Regulators:** Basic linear voltage regulator, fixed output voltage regulators , adjustable output regulator(LM317/LM337), IC voltage	10

	regulators(IC723) **Specialized IC Applications:** Basics of universal active filter, basic phase lock loops, power amplifiers.	

Course Outcome: At the end of the course students will be able to -
CO1: Recall the basics of op-amp.
CO2: Understand the behavior of op-amp linear and non- linear circuits.
CO3: Understand the operation of op-amp in signal processing and oscillator circuits.
CO4: Analyze the application of op-amp in nonlinear circuits.
CO5: Design a circuit or system using integrated circuits.

TEXT BOOKS:

1. David A Bell, "Operational amplifiers and linear ICs**",** 3rd edition, Oxford University Press, 2010.

2. B.Somanathan Nair, "Linear Integrated Circuits - Analysis, Design and Applications", 1st Edition, Wiley India, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. S. Salivahanan, V S KanchanaBhaaskaran, "Linear Integrated Circuits", 2nd Edition, McGraw Hill, 2015.
2. Stanley William D, **"**Operational amplifiers with Linear Integrated Circuits", 4th edition, Pearson Education.
3. Ramakanth A Gayakwad, "Operational amplifiers and linear ICs", 4th edition, PHI, 2009.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 2 and 3 and questions 4 and 5 are to be from unit 2 and unit 3 respectively. Students have to answer Q.2 or Q.3 and Q.4 or Q.5.

3. Questions 1, 6 and 7 are to be set from units 1, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1		*			*						*	
CO2	*	*	*	*								
CO3	*	*	*	*								
CO4		*	*	*	*		*					
CO5	*	*	*	*	*						*	

DR.AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU
(An Autonomous Institution Affiliated To VTU, Belgaum)
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VI SEMESTER B.E, ACADEMIC YEAR 2018-19
Batch 2016

Code No.	Course	Contact Hours/Week			Credits	Maximum Marks		
		Lecture	Tutorial	Lab		Continuous Internal Evaluation	Semester End Evaluation	Total
EE61	Power Systems Analysis	4	0	0	4	50	50	100
EE62	Electrical Machines Design	4	0	0	4	50	50	100
EE63	Digital Signal Processing	3	2	0	4	50	50	100
EE64X	Elective-C	3	0	0	3	50	50	100
EE65X	Elective- D	3	0	0	3	50	50	100
EEL66	DC Machines & Synchronous Machines Lab.	0	0	3	1.5	50	50	100
EEL67	Digital Signal Processing lab	0	0	3	1.5	50	50	100
EEP68	Mini Project	-	-	4	2	50	50	100
TOTAL		**17**	**2**	**10**	**23**	**400**	**400**	**800**

Students Shall Register For One Subject In Each Elective Group			
Elective- Group C (3 credits each)		**Elective- Group D (3 credits each)**	
EE641	Electrical Power Utilization	EE651	Power System Planning
EE642	Electrical Design, Estimation and Costing	EE652	Special Machines
EE643	Programmable Logic Controllers	EE653	Reactive Power Management

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : POWER SYSTEMS ANALYSIS		
Course Code : EE61	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective: Students will learn to

1. Modeling of power system elements and representation the power system in single line diagrams.
2. Use symmetrical components in power system analysis.
3. Perform fault and stability analysis on power system network.
4. Evaluate the performance of induction machine under unbalanced supply conditions.

Unit No.	Syllabus Content	No. of Hours
1	**Representation of Power System Components:** Circuit models of transmission line, synchronous machines, transformers and load. Single line diagram, impedance and reactance diagrams. Per unit system, per unit impedance diagram of power system. **Symmetrical 3 - Phase Faults**: Transient, sub transient and steady state reactance's and currents of synchronous machines. Short-circuit currents of synchronous machines and power system.	11
2	**Symmetrical Components:** Introduction**,** three phase operator-**a**. Synthesis of unbalanced vector from its symmetrical components. Resolution of unbalanced phasors into their symmetrical components. Relation between Line & phase voltages in star connected system. Relation between Line & phase currents in delta connected system. Phase shift of symmetrical components in transformer banks. Power in terms of symmetrical component. Analysis of balanced and unbalanced loads against unbalanced 3 phases supply. Sequence networks of synchronous generators & transformers. Sequence networks of power system.	12
3	**Unsymmetrical Faults:** Single line to ground fault (LGF), line to line fault (LLF), double line to ground fault (LLGF): Determination of faults currents, terminal voltages, and connection of sequence networks. Fault on loaded synchronous generator. Fault with fault impedance. Unsymmetrical faults on power system.	10
4	**Concept of System Stability:** Introduction**,** classification ofstability, steady state and transient stability. Power angle equation of salient and non salient pole machines. Power angle curves. Stability limits and methods to improve stability. Rotor dynamics and the swing equation. Equal area criterion and	10

	critical clearing time. Apply equal area criterion for transient stability evaluation under different operating conditions of power system.	
5	**Unbalanced Operation of Three Phase Induction Motors**: Open conductor faults in power system: sequence network connections. Analysis of three phase induction motor with one line open. Analysis of three phase induction motor with unbalanced supply.	09

Course Outcome: At the end of the course students will be able to -

CO1: Recall the equivalent circuits of power system components and to draw the single line & impedance diagrams of power system network.

CO2: Apply concept of symmetrical components to power system network.

CO3: Analyze the behavior of power system under different fault conditions.

CO4: Evaluate the steady state and transient stability of the Power Systems.

CO5: Investigate the effect of unbalanced operation and single phasing on the Performance of three phase induction machines.

TEXT BOOKS:

1. W.D.Stevenson, Elements of Power System Analysis, TMH,4th Edition
2. I.J.Nagrath and D.P.Kothari- Modern Power System Analysis. TMH, 3rd Edition, 2003.
3 Dr. P.N.Reddy, Symmetrical Components and Short Circuit Studies, Khanna Publishers.

REFERENCE BOOK/WEBSITE LINKS:

1. HadiSadat, Power System Analysis. TMH, 2nd Edition.
2. R.Bergen, and Vijay Vittal Power system Analysis, Pearson publications, 2nd edition, 2006.
3. G.L. Kusic, Computer Aided Power system analysis. PHI.Indian Edition, 2010
4. W.D. Stevenson & Grainger, Power System Analysis. TMH, First Edition, 2003.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 3 and 4 are to be from unit 1 and unit 3 respectively. Students have to answer Q.1 or Q.2 and Q.3 or Q.4.

3. Questions 5, 6 and 7 are to be set from units 3, 4 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*						*			*
CO2	*	*	*	*								*
CO3	*	*	*						*			*
CO4	*	*	*			*					*	
CO5	*	*	*			*						*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : ELECTRICAL MACHINE DESIGN		
Course Code : EE62	No. of Credits: 4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To introduce the knowledge on basic principles of design, limitations and different materials used in electrical machines.
2. To understand the design concepts of static and rotating electrical machines.
3. To design and to interpret the design data of electrical machines.
4. To analyze design problems of machines/devices to satisfy the requirements.

Unit No.	Syllabus Content	No. of Hours
1	**Principles Of Electrical Machine Design:** Introduction, considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines. **Design Of Transformers (Single Phase and Three Phase):** Output equation for single phase and three phase transformers, choice of specific loadings, expression for volts/turn, determination of main dimensions of the core, types of windings and estimation of number of turns and conductor cross sectional area of primary and secondary windings.	12
2	**Estimation of Leakage Reactance and Tank Design of Transformers:** No load current, expression for leakage reactance and voltage regulation. Design of tank and cooling tubes (round and rectangular).	10
3	**Design of DC Machines:** Output equation, choice of specific loadings and choice of number of poles, design of main dimensions of the dc machines, design of armature slot dimensions, commutator and brushes, magnetic circuit - estimation of ampere turns, design of yoke and pole, field windings – shunt, series and inter pole.	10
4	**Design of induction Motors:** Output equation, choice of specific loadings, main dimensions of three phase induction motor, stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor, design of rotor bars and end ring, design of slip ring induction motor, estimation of no load current.	10
5	**Design of Synchronous Machines:** Output equation, choice of specific loadings, short circuit ratio, design of main dimensions, design of the field winding, armature slots and windings, slot details for the stator of salient and non-salient pole synchronous machines.	10

Course Outcome: At the end of the course students will be able to -
CO1: Define basic principles of design, merits and demerits.
CO2: Explain design concepts of power and distribution transformers.
CO3: Explain design concepts of AC and DC rotating electrical machines.
CO4: To solve the problems on design of power and distribution transformers.
CO5: To design the AC and DC rotating electrical machines.

TEXT BOOKS:

1. A.K. Sawhney, A Course in Electrical Machine Design. DhanpattRai& Sons
2. V. N. Mittle, Design of Electrical Machines., 4th edition.

REFERENCE BOOK/WEBSITE LINKS:

1. M.G. Say, Performance and design of AC Machines, CBS Publishers and Distributors Pvt. Ltd.
2. A. Shanmugasundarm, G. Gangadharan, R. Palani, Design Data Handbook. Wiley Eastern Ltd.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 4 and 5 are to be from unit 1 and unit 3 respectively. Students have to answer Q.1 or Q.2 and Q.4 or Q.5.

3. Questions 3, 6 and 7 are to be set from units 2, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1		*	*									
CO2	*		*						*			*
CO3		*										*
CO4			*						*			*
CO5			*						*			*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : DIGITAL SIGNAL PROCESSING		
Course Code : EE63	No. of Credits:4; L:T:P - 3:2:0	No. of hours/week: 03+02
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To understand DFT and its properties,
2. To learn FFT algorithm to find DFT.
3. To understand the structure of IIR & FIR system and to learn Digital IIR filter design using analog filter transformation.
4. To learn Digital FIR filter design

Unit No.	Syllabus Content	No. of Hours
1	**Discrete Fourier Transforms:** Definitions, properties-linearity, shift, symmetry etc., circular convolution – periodic convolution, use of tabular arrays, circular arrays, Stockholm's method, linear convolution – two finite duration sequence, one finite & one infinite duration, overlap add and save methods**.**	8+5
2	**Fast Fourier Transforms Algorithms:** Introduction, decimation in time algorithm, number of computations, number of multiplications, computational efficiency, decimation in frequency algorithms, inverse decimation in time and inverse decimation in frequency algorithms, decomposition for a composite number N=9.	8+5
3	**Realization of Digital Systems:** Introduction, block diagrams and SFGs, realization of IIR systems- direct form, cascaded, parallel form, realization of FIR systems – direct form, cascade form, linear phase realization.	7+5
4	**Design of IIR Digital Filters:** Introduction, impulse invariant & bilinear transformations, all pole analog filters- Butterworth & Chebyshev, design of digital Butterworth & Chebyshev, frequency transformations.	8+5
5	**Design of FIR Digital Filters:** Introduction, windowing, rectangular, modified rectangular, Hamming, Hanning, Blackman window (excluding Kaiser window), frequency sampling techniques.	8+6

Course Outcome: At the end of the course students will be able to -
CO1. Analyze and find DFT of signals.
CO2. Analyze and find DFT using FFT algorithms.
CO3. Realize structures for FIR & IIR systems.
CO4. Design IIR filters for the given specifications.
CO5. Design FIR filters for the given specifications**.**

TEXT BOOKS:

1. Proakis,"Digital Signal Processing Principle, Algorithm & application", Pearson, 4th education, 2009.
2. Sanjeet. K. Mitra,"Digital Signal Processing". TMH, 3rd Edition, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. Johnny R. Johnson"Introduction to Digital Signal Processing", PHI, 2009.
2. Openheim,"Discrete Time Signal Processing "Pearson 2nd Edition 2009.
3. S.Salivahanan, A.Vallaraj, C.Gnanapriya"Digital Signal Processing", TMH, 2nd Edition, 2010.
4. IfeachorEmmaue "Digital Signal Processing" l- Pearson education, 2nd Edition, 2006.
5. Ludeman, "Fundamentals of Digital Signal Processing". John Wiley, 3rd Edition, 2008

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.

3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*						*		*		*
CO2	*	*		*				*		*		*
CO3	*	*						*		*		*
CO4	*	*		*				*		*		*
CO5	*	*		*				*		*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056
ELECTRICAL AND ELECTRONICS ENGINEERING
VI SEMSTER

Course Title : DC Machines & Synchronous Machines Lab.

Course Code : EEL66	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

1. To introduce various testing methods for DC and synchronous machines.
2. To learn various losses occurring in DC machines and to find efficiency of a DC machines.
3. To learn the characteristics, performance and speed control of DC machines.
4. To determine voltage regulation of synchronous machines by various methods.
5. To study the behavior of synchronous machine connected to infinite bus bars.

Unit No.	Syllabus Content
1	Open circuit characteristics of DC machine.
2	Load characteristics of a D.C. shunt and compound generator - i) short shunt-cumulative and differential (ii) Long shunt-cumulative and differential.
3	Load test on a DC motor - determination of speed-torque and HP-efficiency characteristics.
4	Swinburne's test.
5	Hopkinson's test.
6	Speed control of DC motor by armature voltage control and flux control.
7	Ward Leonard method of speed control of D.C. motor.
8	Voltage regulation of an alternator by EMF and MMF method.
9	Voltage regulation of an alternator by ZPF method.
10	Slip test and determination of regulation.
11	Performance of synchronous generator connected to infinite bus under constant power and variable excitation.
12	V and Inverted V curves of a synchronous motor.
13	Field's test on series motors.*
14	Load test on series generator.*
	* - Experiments beyond syllabus

Course Outcome: At the end of the course students will be able to -
CO1: choose proper testing method to determine losses and efficiency of a DC machine and to determine voltage regulation of synchronous generator.
CO2: explain the characteristics of DC machines and synchronous machines by conducting suitable tests.
CO3: apply the basic concept for experimental determination of voltage regulation of synchronous generator.
CO4: analyze the performance of DC machines on load and synchronous machines on infinite bus bars.
CO5: evaluate the losses and efficiency of DC machines and performance of synchronous machines connected to infinite bus bars.

REFERENCES:
1. Laboratory Manual

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*							*	*		*
CO2	*	*							*	*		*
CO3	*	*							*	*		*
CO4	*	*							*	*		*
CO5	*	*							*	*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : DIGITAL SIGNAL PROCESSING LAB		
Course Code : EEL67	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

Unit No.	Syllabus Content
1	Direct Computation of N-point DFT.
2	IIR filter realization using cascade form and Parallel form.
3	IIR Filter Design using Butterworth method.
4	IIR Filter Design using Chebyshev type 1 prototype.
5	IIR Filter Design using rectangular, hamming, window.
6	FIR Filter Design using Hanning, Blackman window.
7	N-Point Circular Convolution and Proof in frequency domain.
8	Circular Convolution, Linear Convolution and Linear Convolution using Circular Convolution.
9	Sampling Theorem.
10	Impulse response from X[n] and y[n].
11	Impulse response from difference equation and response to x[n].
12	N-point DFT using decimation in Time and Frequency FFT.*
13	N-point IDFT using decimation in Time and Frequency FFT.*
	* - Experiments beyond syllabus

Course Outcome At the end of the course students will be able to -
CO1: Write & execute the program to find DFT, Circular Convolution & Linear convolution.
CO2: Write & execute program to find Impulse response of LTI system.
CO3: Differentiate & Write program for FIR & IIR Filter Structures.
CO4: Design & Write program for IIR filters.
CO5: Design & Write program for FIR filters.

REFERENCES:

1. Proakis, Digital Signal Processing Principle, Algorithm & application. Pearson, 4th edition, 2009.
2. Sanjeet. K. Mitra, Digital Signal Processing. TMH, 3rd edition, 2009.
3. Laboratory Manual

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*			*			*		*		*
CO2	*	*		*	*			*		*		*
CO3	*	*			*			*		*		*
CO4	*	*		*	*			*		*		*
CO5	*	*		*	*			*		*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : ELECTRICAL POWER UTILIZATION		
Course Code : EE641	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. To learn electrical energy utilization in industrial and domestic applications.
2. Introduce to the students the applications of electric and hybrid machines in traction system.

Unit No.	Syllabus Content	No. of Hours
1	**Electric heating:** Advantages and methods of electric heating, resistance ovens, induction heating, dielectric heating, the arc furnace.	08
2	**Electric welding:** Resistance and arc welding, control devices and welding equipment. **Electrolytic process:** Fundamental principles, extraction, refining of metals and electroplating. Factors affecting electro deposition process, power supply for electrolytic process.	07
3	**Illumination:** Laws of illumination, lighting calculation, factory lighting, flood lighting, street lighting, different types of lamps-incandescent, fluorescent, vapor, cfl and led lamps and their working, comparison, glare and its remedy.	07
4	**Electric traction:** Introduction, requirements of an ideal traction, **s**ystems of traction, speed time curve, tractive effort, co-efficient of adhesion, specific energy, factors affecting specific energy consumption. Selection of traction motors, method of speed control, energy saving by series parallel control, electric braking.	09
5	**Ac traction:**AC traction equipment, diesel electric equipment. Ac series motor – characteristics, linear induction motor and their use, trains lighting system. **Introduction to electric and hybrid vehicles:** Configuration and performance of electrical vehicles, traction motor characteristics, tractive effort, transmission requirement, vehicle performance and energy consumption.	08

Course Outcome: At the end of the course students will be able to -
CO1: Classify and explain - electric heating methods and furnaces, compare different heating methods. (L1 and L2)

CO2: Apply the basic concepts of electrical engineering in utilization of electrical power for industry and domestic applications. (L3)

CO3: Analyze systems of electric traction, motors for traction and their control. (L4)

CO4: Evaluate systems of traction and traction equipment, construct block diagram for electric and hybrid vehicles. (L5)

CO5: Design lighting schemes for industrial and domestic applications. (L6)

TEXT BOOKS:

1. Utilization of Electric Energy. E Openshaw Taylor, 12th Impression, 2009, Universities Press.

2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles. Mehrdad, Ehsani, Yimin Gao, Sabastien. E. Gay, Ali Emadi- CRC Press.

REFERENCE BOOK/WEBSITE LINKS:

1. A Course in Electrical Power. Soni Gupta and Bhatnager-Dhanapat Rai & sons.

2. Electrical Power. Dr. S.L.Uppal, Khanna Publications.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 5 and 6 are to be from unit 1and unit 4 respectively. Students have to answer Q.1 or Q.2 and Q.5 or Q.6.

3. Questions 3, 4 and 7 are to be set from units 2, 3 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*								*
CO2	*	*	*	*								*
CO3	*	*	*	*								*
CO4	*	*	*	*								*
CO5	*	*	*	*								*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : ELECTRICAL DESIGN, ESTIMATION AND COSTING		
Course Code : EE642	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. Calculation or computation of all required engineering materials and expenditure likely to be incurred in carrying out a given work before execution, residential building electrification, General rules guidelines for wiring of residential installation and positioning of equipments, and earthing procedures.
2. To understand various types of service connections, inspection and testing of wiring installations, electrical installation for power circuits, design and estimation of overhead Transmission and Distribution lines.

Unit No.	Syllabus Content	No. of Hours
1	**GENERAL PRINCIPLES OF ESTIMATION:** Introduction to estimation & costing, electrical schedule, catalogues, market survey and source selection, recording of estimates, determination of required quantity of material, labor conditions, determination of cost material and labour, contingencies, overhead charges, profit, purchase system, purchase enquiry and selection of appropriate purchase mode, comparative statement, purchase orders, payment of bills, tender form, general idea about i.e. rule, Indian electricity act and major applicable I.E rules.	**07**
2	**RESIDENTIAL BUILDING ELECTRIFICATION:** General rules guidelines for wiring of residential installation and positioning of equipments, principles of circuit design in lighting and power circuits, procedures for designing the circuits and deciding the number of circuits, method of drawing single line diagram, selection of type of wiring and rating of wires and cables, load calculations and selection of size of conductor, selection of rating of main switch, distribution board, protective switchgear ELCB and MCB and wiring accessories, earthing of residential installation, sequence to be followed for preparing estimate, preparation of detailed estimates and costing of residential installation.	**07**
3	**SERVICE CONNECTION, INSPECTION AND TESTING OF INSTALLATION:** Concept of service connection, types of service connection and their features, method of installation of service connection, estimates of under - ground and overhead service connections, inspection of internal wiring installations, inspection of new installations, testing of installations, testing of wiring installations.	**08**
4	**ELECTRICAL INSTALLATION FOR POWER CIRCUITS:** Introduction, important considerations regarding motor installation wiring, determination of input power, determination of input current to motors, determination of rating of cables, determination of rating of fuse, determination of size of conduit, distribution board main switch and starter.,	**08**

	reason for excess recording of energy consumption by energy meter.	
5	**DESIGN AND ESTIMATION OF OVERHEAD TRANSMISSION & DISTRIBUTION LINES:** Introduction, typical ac electrical power system, main components of overhead lines, line supports, factors governing height of pole, conductor materials, determination of size of conductor for overhead transmission line, cross arms, pole brackets and clamps, guys and stays, conductors configuration spacing and clearances, span lengths, overhead line insulators, insulator materials, types of insulators, lightning arrestors, phase plates, danger plates, anti climbing devices, bird guards, beads of jumpers, muffs, points to be considered at the time of erection of overhead lines, erection of supports, setting of stays, fixing of cross arms, fixing of insulators, conductor erection, repairing and jointing of conductor , dead end clamps, positioning of conductors and attachment to insulators, jumpers, tee-offs, earthing of transmission lines, guarding of overhead lines, clearances of conductor from ground, spacing between conductors, testing and commissioning of overhead distribution lines, some important specifications.	**09**

Course Outcome: At the end of the course students will be able to -

CO1: apply the knowledge of electrical engineering drawing, IE rules, NEC, different types of electrical installation, their design considerations and equipments.

CO2: Design and prepare working drawing of different Installation projects.

CO3: Understanding of the methods and procedure of estimating the material required.

CO4: Enables the student to develop the skill of preparing schedule of material.

CO5:To prepare detailed estimates; costing of different types of Installation which leads to preparing of the tender documents, procedure for tendering, evaluation and billing of executed work of different types of electrical Installation Project.

TEXT BOOKS:

1. Electrical Installation Estimating & Costing, J.B.Gupta, VIII Edition S.K. Katria& Sons New Delhi.

REFERENCE BOOK/WEBSITE LINKS:

1. Electrical Design Estimating and Costing,K.B.RainaS.K.Bhattacharya, New Age International
2. Electrical Wiring Estimating and Costing,Uppal, Khanna Publishers Delhi

I.E. Rules and Act Manuals

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.

3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*						*	*	*
CO2	*	*		*						*	*	*
CO3	*	*		*						*	*	*
CO4	*	*		*						*	*	*
CO5	*	*		*	*	*		*	*	*	*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : PROGRAMMABLE LOGIC CONTROLLERS		
Course Code : EE643	No. of Credits:4; L:T:P - 3:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. The need of automation in the industry with basic controller mechanisms involved.
2. The programming concepts to achieve the desired goal or to define the various steps involved in the automation and the programming languages involved with basic subroutine functions.
3. To make use of the internal hardware circuits of automation circuit to control the devices during various states with monitoring the timers and counters.
4. To handle the data of the I/O devices to interface the data with the controller and auxiliary devices.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction:** Introduction to programmable logic controller (plc), role in automation (scada), advantages and disadvantages, hardware, internal architecture, sourcing and sinking, characteristics of I/O devices, list of input and output devices, examples of applications. I/O processing, input/output units, signal conditioning, remote connections, networks, processing inputs i/o addresses.	11
2	**Programming:** Ladder programming- ladder diagrams, logic functions, latching, multiple outputs, entering programs, functional blocks, program examples like location of stop and emergency switches.	10
3	**Programming Languages:** Instruction list, sequential functions charts & structured text, jump and call subroutines**.**	10
4	**Internal Relays:** Ladder programs, battery- backed relays, and one - shot operation, set and reset, master control relay. **Timers and Counters**: Types of timers, programming timers, on and off-delay timers, pulse timers, forms of counter, programming, up and down counters, timers with counters, sequencer.	11
5	**Shift Register And Data Handling**: Shift registers, ladder programs, registers and bits, data handling, arithmetic functions, temperature control and bottle packing applications.	10

Course Outcome: At the end of the course students will be able to -

CO1: Need of automation and its various control strategies with its auxiliary devices.

CO2:Programs for various functional block consisting of multiple inputs and outputs and to control

CO3:Programming issues with subroutines and debugged

CO4: The use of auxiliary units of a controller with hardware exposure.

CO5: The data handling with simple hardware.

TEXT BOOKS:

1. Programmable Logic controllers**.** W Bolton, 5th edition, Elsevier- newness, 2009.
2. 2**.** Programmable logic controllers **-** principles and applications. John W Webb, Ronald A Reis, Pearson Education, 5th edition, 2nd impression, 2007.

REFERENCE BOOK/WEBSITE LINKS:

1. Programmable Controller Theory and Applications, L.A.Bryan, E. A Bryan, An industrial text company publication, 2nd edition, 1997.
2. Programmable Controllers, An Engineers Guide. E. A Paar, newness, 3rd edition, 2003.https://onlinecourses.nptel.ac.in

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 5 and 6 are to be from unit 1 and unit 4 respectively. Students have to answer Q.1 or Q.2 and Q.5 or Q.6.

3. Questions 3, 4 and 7 are to be set from units 2, 3 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*								
CO2	*		*	*							*	
CO3			*	*	*							
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : POWER SYSTEM PLANNING		
Course Code : EE651	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective: To learn

1. Structure of power system, grid system, Load fore casting and modeling.
2. Integrated and co generation, power pooling trading, financial planning and tariffs.
3. Computer aided planning, green house effect, insulation coordination and reactive power compensation.
4. Reliability of power supply, load prediction, power system expansion and management.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction of Power Planning**: National and regional planning, structure of power system, planning tools, electricity regulation, Load forecasting, forecasting techniques, modeling.	07
2	**Generation Planning**: Integrated power generation, co-generation / captive power, power pooling and power trading, transmission & distribution planning, power system economics, power sector finance, financial planning, private participation, rural electrification investment, concept of rational tariffs.	08
3	**Computer Aided Planning:** Wheeling, environmental effects, green house effect, technological impacts, insulation co-ordination, reactive compensation.	07
4	**Power Supply Reliability**: Reliability planning, system operation planning, load management, load prediction, reactive power balance, online power flow studies, test estimation, computerized management. Power system simulator.	08
5	**Optimal Power System Expansion Planning**: Formulation of least cost optimization problem incorporating the capital, operating and maintenance cost of candidate plants of different types (thermal, hydro, nuclear, non conventional).	09

Course Outcome: At the end of the course students will be able to –
CO1: How to the plan the structure of power system and to model it, outline of grid in India
CO2:Explain finance, tariff, private sector participation and rural electrification.
CO3:Analyze the environmental effects, green house effect, technological impacts, insulation co-ordination, in power system planning.
CO4:Determine the reliability of planning, load management, load reactive power balance.
CO5:Formulate the least cost optimization problem, operating and maintenance cost of candidate plants.

TEXT BOOKS:

1. A.S.Pabla, Electrical Power System Planning. Macmillan India Ltd, 1998

REFERENCE BOOK/WEBSITE LINKS:

1. S.S. Murthy, **Power System Planning and Control**

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.

3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*		*	*	*			
CO2	*	*			*			*	*		*	*
CO3	*	*	*		*		*	*	*			
CO4	*	*			*			*	*		*	*
CO5	*	*	*		*			*	*		*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : SPECIAL MACHINES		
Course Code : EE652	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. Understand the concepts of Special electrical machines.
2. Analyze the necessity of sensors used in Special electrical machines.
3. Explain the characteristics and different speed - torque control schemes.
4. Model the electrical machines with voltage, current, torque and speed equations.

Unit No.	Syllabus Content	No. of Hours
1	**Stepper Motor:** Types of motors, working, windings, torque equation, characteristic, single stack stepper motor, PMSM, open and closed loop control, and microprocessor/microcontroller based control of motors, comparison of stepper motors, applications.	08
2	**Switched Reluctance Motor (SRM):** Construction, working, basics of SRM, pole arc and tooth arc, torque equation, characteristics, power converter circuits, sensors, microprocessor/microcontroller based control of SRmotor and applications.	08
3	**Brushless Permanent Magnet DC (BLDC) Motor**: Permanent magnet materials and BH curves, Classification of BLDC motors, construction, working, electronic commutation, principle of operation, square wave generator, types of motors, and digital control of motors, Necessity of Hall sensors and optical sensors, comparison of brushed and brushless dc motors & applications.	08
4	**Permanent Magnet Synchronous Motor (PMSM):** Construction, principle of operation, emf equation, torque equation, phasor diagram, circle diagram, comparison of conventional and PMSM motors, digital control PMSM motors and applications.	07
5	**Linear Induction Motor and Axial Flux Machines**: Construction, types, Principle of operation, thrust equation, goodness factor, equilent circuit, characteristics control of LIM- block diagram, voltage inverter circuit and applications. **Axial Flux Machines**: Comparison- PMRF and PMAF machines, Construction, Torque equation, control of PMAFMs, applications.	08

Course Outcome: At the end of the course students will be able to -
CO1: Understand the construction and operation of different special electrical machines.

CO2: Compare merits, demerits of different special electrical machines and their applications.

CO3: Explain the control and performance parameters of special electrical machines.

CO4: Develop torque equation and analyze speed –torque characteristics of special electrical machines.

CO5: Analyze different power converter topologies for operation of special electrical machines.
CO6: Apply digital control techniques for the operation and control of special electrical machines.

TEXT BOOKS:

1. E.G. Janardhanan,Special Electrical Machines, PHI, 2014.
2. K. Venkataratnam, Special Electrical Machines, University Press, Reprint, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. Miller, T.J.E.“Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, Oxford, 1989.

2. Kenjo, T, “Stepping Motors and their Microprocessor control”, Clarendon Press, Oxford, 1989.
3. Naser A and Boldea I, “Linear Electric Motors: Theory, Design and Practical Application”, Prentice Hall Inc., New Jersey,1987
4. R.Krishnan, Switched Reluctance motor drives-Modeling, Simulation, Analysis, Design, and Applications, CRC Press, 2015.
https://onlinecourses.nptel.ac.in/

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 3 and 4 and questions 6 and 7 are to be from unit 3 and unit 5 respectively. Students have to answer Q.3 or Q.4 and Q.6 or Q.7.

3. Questions 1, 2 and 5 are to be set from units 1, 2 and 4 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1		*										
CO2			*									
CO3			*									
CO4				*			*					
CO5					*		*					*
CO6									*	*	*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : REACTIVE POWER MANAGEMENT		
Course Code : EE653	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. Importance of Reactive Power, in a power system and Harmonics and Compensation methods.

2. Reactive power control in Transmission schemes. Discussion on effects of Transmission line length, Load power and power factor on Reactive power.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction**: Importance of reactive power control in EPS, Reactive power devices. Theory of Load Compensation: Introduction- Requirement for compensation, Objectives in load compensation, Specifications of a load compensator, Power factor correction and voltage regulations in single phase system, Phase balancing and PF correction of unsymmetrical loads, Compensation in term of symmetrical components.	8
2	**Reactive Power Control**: Fundamental requirement in AC Power transmission, Fundamental transmission line equation, Surge impedance and natural loading, Voltage and current profiles of uncompensated radial and symmetrical line on open circuit, Uncompensated line under load, Effect of line length, Load power and PF on voltage and reactive power.	8
3	**Passive and Active compensators**: Uniformly distributed fixed compensation, Passive shunt compensation, Control of open circuit voltage by shunt reactance, Reactance of shunt reactors, multiple shunt reactors along the line.	7
4	**Series Compensation**: Objectives and practical limitations, Symmetrical line with mid-point series capacitor and shunt reactor, Power transfer characteristics and maximum transmissible power for a general case, Fundamental concepts of compensation by sectioning. **Principles of Static Compensation**: Principle of operation of thyristor controlled reactor, Thyristors switched capacitor. Series Capacitors: Introduction, protective gear, reinsertion schemes, Varistor protective gear.	8

5	**Synchronous Condenser**: Introduction, Power system Voltage control, Emergency reactive power supply, Starting methods, starting motor, reduced voltage starting, static starting. **Harmonic effects**: Resonance, Shunt Capacitors and Filters, telephone interferences, Reactive Power Co-ordination, Reactive power management, transmission benefits, and reactive power dispatch & equipment impact.	8

Course Outcome: At the end of the course students will be able to -

CO1: Able to understand how Reactive power supply is essential for reliably operating the electric transmission system.

CO2: Able to Understand the effects of inadequate reactive power (voltage collapses and major power outages).

CO3:Undertstand passive and active compensators.

CO4: Able to Have the knowledge of various methods of load and line Compensations.

CO5: Able to Understand theory and applications of synchronous condensers, various effects of harmonics and Reactive power management.

TEXT BOOKS:

1. Reactive power control in electric power systems. T. J. E. Miller, BSP books Pvt Ltd, 2011.
2. Reactive Power Management. D. Tagare, TMH, 1st Edition, 2004.

REFERENCE BOOK/WEBSITE LINKS:

1. Power System Stability and Control. P. Kundur, TMH, 9th reprint, 2007.
2. Power System Voltage Stability. Carson. W. Taylor, McGraw-Hill, Inc.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.

3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*			*			*	*	*
CO2		*	*	*	*		*			*		
CO3		*	*		*						*	*
CO4	*	*	*						*	*	*	*
CO5			*	*			*			*	*	*

DR.AMBEDKAR INSTITUTE OF TECHNOLOGY, BANGALORE

(An Autonomous Institution Affiliated To VTU, Belgaum)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VII SEMESTER B.E, ACADEMIC YEAR (2018-19)

Batch – 2015

CODE NO.	COURSE	CONTACT HOURS/WEEK			CREDITS	MAXIMUM MARKS		
		LECTURE	TUTORIAL	LAB		CONTINUOUS INTERNAL EVALUATION	SEMESTER END EVALUATION	TOTAL
HS04	Intellectual Property Rights	2	0	0	2	25	25	50
EE71	Computer Techniques in Power System Analysis	3	2	0	4	50	50	100
EE72	High Voltage Engineering	4	0	0	4	50	50	100
EE73X	Elective – E	4	0	0	4	50	50	100
$	Inter Department Elective	4	0	0	4	50	50	100
EEL74	Relay & HV Lab	0	0	3	1.5	50	50	100
EEL75	Power Systems Simulation Laboratory	0	0	3	1.5	50	50	100
EEL76	Computer Aided Electrical Drawing	1	0	4	3	50	50	100
EEP77	Project Work Phase-I	--	--	4	--	50	-	50
TOTAL		17	2	10	24	375	325	700
$ -elective code of the department offering the course *Students shall register for a course offered by the other departments.								

PROFESSIONAL ELECTIVE- GROUP E (4 credits each)			
EE73	Flexible AC Transmission Systems(FACTS)	EE73	Fuzzy Logic
EE73	Energy Auditing & Demand Side Management	EE73	Artificial Neural Network
EE73	Power Systems Dynamics & Stability	EE73	Electrical Power Quality
EE73	Embedded Systems	EE73	Advanced Power Electronics*
Student shall register for one course in the elective group – E			
Inter Department Electives: Students who have not completed the IDE should register for the completion of 200 credits. According to section 16.2, Academic Regulations of Dr AIT, the credits registered should not exceed 30.			

Inter - Departmental Electives offered by the Department			
EEE01	Renewable Energy Sources	EEE02	Advanced Power Electronics

DR. AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : COMPUTER TECHNIQUES IN POWER SYSTEMS ANALYSIS		
Course Code : EE71	No. of Credits:4; L:T:P - 3:2:0	No. of hours/week: 3+2
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 65

Course Objective: Students will be able to

1 Understand Network Topology, Network matrices to formulate Ybus and Zbus
2 Perform Load flow analysis using different numerical techniques.
3 Perform economic operation on power system.
4 Evaluate transient stability analysis of power system.

Unit No.	Syllabus Content	No. of Hours
1	**Network Matrices:** Introduction, elementary graph theory – oriented graph, tree, co-tree, cut set, loop. Incidence matrices: element-node, bus, basic cut set, basic loop. Primitive network – impedance form and admittance form. Formation of Y_{BUS} by method of inspection (including transformer off-nominal tap setting) and by method of singular transformation (Y_{BUS} = A^TyA). Formation of bus impedance matrix by step by step building algorithm (without mutual coupling elements).	8+6
2	**Load Flow Studies 1:** Introduction, power flow equations, classification of buses, operating constraints, data for load flow, Gauss-Seidal method – formulation of voltage equation. Algorithm and flow chart for PQ and PV buses (numerical problems for one iteration only).	8+5
3	**Load Flow Studies 2:** Newton-Raphson's method – formulation of power residue equations, evaluation of Jacobian elements. Algorithm and flow chart in polar coordinates (numerical problems for one iteration only). Fast decoupled load flow. Comparison of load flow methods.	9+5
4	**Economic Operation Of Power System:** Introduction, performance curves, economic generation scheduling neglecting losses and generator limits. Economic generation scheduling including generator limits and neglecting losses, iterative techniques. Economic dispatch including transmission losses – approximate penalty factor, iterative technique for solution of economic dispatch with losses. Derivation of transmission loss formula.	8+6
5	**Transient Stability Studies:** Introduction to transient stability. Numerical solution of swing equation – point-by-point method, modified Euler's method, Milne's Method, Runge-Kutta method.	6+4

Course Outcome: At the end of the course students will be able to -

CO1: Recall and relate the graph theory to Power System, define fundamental matrices and form Ybus and Zbus matrices
CO2: Classify the buses and formulate the power flow problems of power system network.
CO3: Solve the power flow problems through different iterative techniques.
CO4: Analyze the economic operation of power system under various operating conditions.
CO5: Evaluate the transient stability of the power system through different numerical methods.

TEXT BOOKS:

1 Stag G. W. and EI-Abiad A. H., **Computer Methods in Power System Analysis,** McGraw Hill International Student Edition. 1968
2 Haadi Sadat**, Power System Analysis,** TMH, 2nd Edition, 12th reprint, 2007
3 Pai M. A, **Computer Techniques in Power System Analysis**, TMH, 2nd edition, 2006.
4 Uma Rao, Computer Techniques in Power System, IK International Publishing House pvt. Ltd., Bangalore

REFERENCE BOOK/WEBSITE LINKS:

1. Singh L.P **Advanced Power System Analysis and Dynamics**, New Age International (P) Ltd, New Delhi, 2001.
2. Dhar R.N, **Computer Aided Power System Operations and Analysis**"- TMH, 1984.
3. Nagrath I. J., and Kothari D. P, **Modern Power System Analysis,** TMH, 3rd Edition, 2003.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1and 2 and questions 5 and 6 are to be from unit 1 and unit 4 respectively. Students have to answer Q.1 or Q.2 and Q.5 or Q.6.

3. Questions 3, 4 and 7 are to be set from units 2, 3 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*				*			*		*
CO2	*	*		*	*			*				*
CO3	*	*		*	*					*		*
CO4	*	*		*	*					*		*
CO5	*	*	*	*		*				*		

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : HIGH VOLTAGE ENGINEERING		
Course Code : EE72	No. of Credits: 4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective: To impart the students

1. The basics of High voltage Engg and to learn Break down mechanisms of insulating media
2. The concepts on generation of High AC. DC and impulse voltages and currents.
3. To learn technique of measurement of High AC, DC and impulse voltages and currents.
4. To understand the testing of high voltage equipments.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction:** Introduction to HV technology, role of insulation in electrical apparatus, need for generating high voltages in laboratory. Industrial applications of high voltage. **Breakdown phenomena:** Classification of HV insulating media. Properties of important HV insulating media under each category. **Gaseous dielectrics**: Ionization: primary and secondary ionization processes. Criteria for gaseous insulation breakdown based on Townsend's theory. Limitations of Townsend's theory. Streamer's theory of breakdown in non-uniform fields. Corona discharges. Breakdown in electro negative gases. Paschen's law and its significance. Time lags of breakdown. **Solid dielectrics**: Breakdown in solid dielectrics: intrinsic breakdown, avalanche breakdown, thermal breakdown, and electro mechanical breakdown. **Liquid dielectrics**: Breakdown of liquid dielectrics: Suspended particle Theory, Cavity breakdown (Bubble's theory), and Stressed Oil Volume theory.	12
	Generation of HVAC voltages: HVAC-HV transformer; need for cascade connection and working of transformers units connected in cascade. Series resonant circuit- principle of operation and advantages. Tesla coil. **Generation of HVDC voltages:** Half and full wave rectifier circuits, voltage doubler circuit, Cockroft-walton type high voltage generator set. Calculation of voltage regulation, ripple and optimum number of stages for minimum voltage drop. Electrostatic generators - Van–de-graff generator.	10
3	**Generation of impulse voltage and current:** Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator-expression for output impulse voltage. Multistage impulse generator, working of modified Marx multi stage impulse generator circuit. Rating of impulse generator. Components of multistage impulse generator. Triggering of impulse generator by three electrode gap arrangement. Trigatron gap and oscillograph time sweep circuits. Generation of switching impulse voltage. Generation of high impulse current.	10
4	**Measurement of high voltages:** Electrostatic voltmeter-principle, construction and limitation. Chubb and fortescue method for HVAC measurement. Generating voltmeter- principle, construction. Series resistance micro ammeter for HVDC measurements. Standard sphere gap- measurement of HVAC,	10

	HVDC, and impulse voltages; factors affecting the measurements. Potential dividers-Resistance dividers, Capacitance dividers and mixed RC potential dividers. Measurement of high impulse currents- Magnetic links.	
5	**Non-destructive insulation testing techniques:** dielectric loss and loss angle measurements using Schering bridge, transformer ratio arm bridge. Need for discharge detection and pd measurements aspects. Factor affecting the discharge detection. Discharge detection methods-straight and balanced methods. **High voltage tests on electrical apparatus**: Definitions of terminologies, tests on Isolators, Circuit Breakers, Cables, Insulators, Bushings and Transformers.	10

Course Outcome: At the end of the course students will be able to -
CO1: Explain the need for high voltages and currents\.
CO2: Explain the physics of break down mechanisms of insulating media.
CO3: Compare the merits and demerits of generation of high voltage and currents.
CO4: Select suitable method for measurement of high voltages and currents.
CO5: Explain the method of conducting the high voltage tests on different electrical equipments.

TEXT BOOKS:
1. M.S.Naidu and Kamaraju, High Voltage Engineering, - 4th Edition, TMH, 2008.
2. E.Kuffel and W.S. Zaengl, High Voltage Engineering Fundamentals, 2nd Edition, Elsevier Press,2005.

REFERENCE BOOK/WEBSITE LINKS:
1. R.S. Jha, High Voltage Engineering, DhanpatRai& Sons, New Delhi, 1984.
2. Mazen Abdel-Salam, Hussein Anis, Ahdab El- Morshedy, RoshdyRadwan, High Voltage Engineering Theory and Practice, 2nd Edition (Revised & Expanded) Marcel-Dekker Publishers (Special Indian edition.).

INSTRUCTIONS TO PAPER SETTERS
1: Students have to answer five full questions of 20 marks each.
2: Questions 1 and 2 and questions 3 and 4 are to be from unit 1 and unit 2 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.
3. Questions 5, 6 and 7 are to be set from units 3, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*											*
CO2	*						*					*
CO3		*					*					*
CO4		*		*								*
CO5			*									*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIISEMESTER		
Course Title : RELAY AND HIGH VOLTAGE LABORATORY		
Course Code : EEL74	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:
1. To study the characteristics of various protection devices.
2. To study the flashover characteristics of air insulation subjected to HVAC and HVDC under uniform and non-uniform field configuration.
3. To study the field distribution in the conductor dielectric medium.
4. To study the generation of standard lightning impulse voltage wave and to evaluate the front and tail times.

Unit No.	Syllabus Content
1	Operating characteristics of non-directional over-current (electro-mechanical) relay.
2	IDMT characteristics of over voltage or under voltage relay.(solid state or electromechanical type)
3	a) To determine 50% probability flashover voltage for air insulation subjected to impulse voltage. (b) Generation of standard lightning impulse voltage and to determine efficiency and energy of impulse generator.
4	Operating characteristics of over voltage or under voltage relay. (Solid state or electromechanical type).
5	Current-time characteristics of fuse.
6	Operating characteristics of microprocessor based (numeric) over –current relay.
7	Operating characteristics of microprocessor based (numeric) over/under voltage relay.
8	Motor protection scheme-fault studies.
9	Spark over characteristics of air insulation subjected to high voltage AC, with spark over voltage corrected to STP for uniform and non-uniform field configuration.
10	Spark over characteristics of air insulation subjected to high voltage DC for uniform & non-uniform field configurations with spark-over voltage corrected to STP.
11	Measurement of HVAC and HVDC using standard spheres.
12	Breakdown strength of transformer oil using oil-testing unit.
13	Field mapping using electrolytic tank for any one-model cable/capacitor/transmission line/ Sphere gap models.
14	Demonstration of cascade connection of transformers*
15	Measurement of partial discharges in underground cables*
	*- experiments beyond syllabus.

Course Outcome: At the end of the course students will be able to -
CO1: Identify the characteristics of protection devices for applications in power system protection[L2,CO1,PO1]
CO2: Distinguish between the flashover characteristics of air insulation subjected to HVAC under uniform and non- uniform field configuration[L4,CO2,PO3]
CO2: Distinguish between the flashover characteristics of air insulation subjected to HVDC under uniform and non- uniform field configuration[L4,CO2,PO3]
CO3: Illustrate the generation of standard lightning impulse voltage wave and to evaluate front and tail times.
CO4: Asses the field strength in liquid insulation and field distribution in the dielectric medium through field plotting.

REFERENCES:

1. Department Lab Manual.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*											*
CO2		*	*									*
CO3		*	*									*
CO4		*	*									*
CO5				*			*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIISEMESTER		
Course Title : POWER SYSTEM SIMULATION LABORATORY		
Course Code : EEL75	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

1. Acquire skills of using computer packages like MATLAB (coding and SIMULINK) in Power system studies.
2. Acquire skills of using MiPower package for designing and analysis of electrical power networks and investigate typical case study problems.

Unit No.	Syllabus Content
1	Using MATLAB, (i) Y-bus formation for power system without mutual coupling by singular transformation & (ii) inspection method.
2	Determination of bus currents, bus power and line flows for a specified system voltage (bus) profile.
3	Using MATLAB-Determination of power angle diagrams for (i) salient and (ii) non-salient pole synchronous machines, reluctance power, excitation emf and regulation
4	Using Mi-Power, to determine fault currents and voltages in a single transmission line system with star-delta transformers at a specified location for (i) SLGF, (ii) DLGF and (iii) LLF.
5	Using MATLAB-To determine i) Swing curve ii) critical clearing time for a single m/c connected to infinite bus through a pair of identical transmission lines, for a 3-phase Fault on one of the lines for variation of inertia constant / line parameters / fault location / clearing time / pre fault electrical output.
6	Using Mi-power, Load flow analysis for (i) three bus (ii) five bus system using Gauss Seidal and Newton Raphson method.
7	Using MATLAB- Gauss Seidel method for Load flow Analysis for one iteration for the given power system.
8	Using Matlab, Formation of Jacobian for a system not exceeding four buses (no PV buses)
9	Using Mi-Power, Optimal generator scheduling for thermal power plants.
10	Using MATLAB, Optimal generator scheduling for thermal power plants
11	Using MATLAB- Load flow analysis by Newton Raphson method*
12	Y- bus formation for power system with mutual coupling by singular transformation method.*
	* - Experiments beyond syllabus

Course Outcome: At the end of the course students will be able to -
CO1: Experiment with software packages (Matlab and MiPower) to solve Power system parameters.
CO2: Develop programs and models using computer based tools for optimal generator scheduling.
CO3: Analyze different types of faults for stability studies.
CO4: Compute Load flow parameters using numerical methods.
CO5: Apply the knowledge to solve real time problems.

REFERENCES:
1. EEE Department Lab Manual,
2. PRDC Lab Manual

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*											*
CO2	*		*	*	*		*	*	*	*		
CO3	*	*	*	*			*		*			
CO4	*	*		*								*
CO5	*		*		*		*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMSTER		
Course Title : COMPUTER AIDED ELECTRICAL DRAWING		
Course Code : EEL76	No. of Credits:3; L:T:P - 0:2:2	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50+ 50 = 100 Marks	

Course Objective: In this course students will learn

1. The various kinds of armature winding used in electrical machines and the arrangement of the entire winding
2. Assembly drawing showing, how the different parts fit together and provide sufficient information to enable the assembly of a component.
3. Sectional views showing how parts fit and expose hidden details, clearly in the simplest and shortest way.
4. The computer drafting skill to express ideas on a paper through the medium of drawing.

Unit No.	Syllabus Content
1	Single layer Lap and Wave windings
2	Double layer Simplex Lap and Wave windings
3	Double layer duplex Lap and Wave windings
4	Equalizers and dummy coils
5	Integral and Fractional slot double layer Lap windings, short pitch ac windings
6	Integral and Fractional slot double layer Wave windings, short pitch ac windings
7	Hemitropic Un-bifurcated 2 and 3 tier windings, Bifurcated 2 and 3 tier windings, mush type windings.
8	Transformers sectional views of a limb and core type single phase and three transformers
9	Single phase Shell type transformers sectional views
10	Synchronous Machines: Sectional views of Rotor and stator.
	Beyond the Syllabus
1	D.C. machine: sectional views of a pole, yoke & field assembly, armature and commutators dealt separately
2	Sectional views stator and rotor of Induction Machine

Course Outcome: At the end of the course students will be able to -

CO1. Recognize the various types armature winding patterns of rotating dc_ machines

CO2. Draw the diagrams armature winding patterns of rotating ac_ machines.

CO3. Develop the winding patterns suitable for the ratings of the machines

CO4. Assemble the various parts and draw their sectional views from given data

CO5. Analyze and draw the sectional assembled views of various machines from the given data

REFERENCE;

1. M. G. Say, Performance & Design of Alternating Current machines. CBS publishers, 3rd Edition, 2002.

2. A.E Clayton & N.N.Hancock, The Performance & Design of DC machines. CBS Publication, 3rd Edition, 2004.

3. A K Sawhney, Electrical Machine Design. Khanna Publishers.

4. SF Devalapur, Electrical Drafting, EBPB Publication, 8th Edition, 2010

5. KL Narang, Electrical Engineering Drawing, Tech India Publications, 3rd Edition, 1986.

6. Dr. Indrani MS, Shankarlal VD & Beaula D, CAD for Electrical Engineers, Singuine Technical Publishers, Bengaluru, 2nd Edition, 2015

7. Auto CAD Manuals

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*			*					*		*	
CO2	*			*					*		*	
CO3	*			*					*		*	
CO4	*			*					*		*	
CO5	*			*					*		*	

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : FLEXIBLE A.C. TRANSMISSION SYSTEMS (FACTS)		
Course Code : EE731	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To understand the important parameters which play a vital role in power transmission.

2. To learn the concept of compensations required for a power system and the method of compensations implemented.

Unit No.	Syllabus Content	No. of Hours
1	**FACTS, Concepts And General System Configuration**: Power Transmission, interconnection, flow of power in ac system, power flow and dynamic stability consideration of a transmission interconnection, relative importance of controllable parameters, and basic types of facts controllers, shunt, series, combined shunt and series connected controllers.	**07**
2	**POWER SEMICONDUCTOR DEVICES**: Types of high power devices, principle of high power device characteristics and requirements, power device material, diode, MOSFET, MOS Turn Off Thyristor, Emitter Turn OFF Thyristor, Integrated Gate Commuted Thyristor (GCT & IGCT).	**07**
3	**VOLTAGE SOURCED CONVERTERS**: basic concepts, single-phase full wave bridge converter operation, a single-phase bridge converter and 3-phase full wave bridge converter for square wave harmonics. **SELF AND LINE COMMUTATED CURRENT SOURCE CONVERTER**: Basic concepts, 3 phase full wave rectifier, thyristor based converter, current sourced converters with turnoff devices, and current source converters versus voltage source converters.	**09**
4	**STATIC SHUNT COMPENSATORS SVC AND STATCOM**: Objective of shunt compensation, methods of controllable VAR generation, static VAR compensator, SVC And STATCOM, comparison between SVC And STATCOM.	**08**
5	**STATIC SERIES COMPENSATORS:** GCSC, TSSC, TCSC And SSSC, objectives of series compensation, variable impedance type of series compensation, switching converters, types, series compensation, external control for series reactive compensators.	**08**

Course Outcome: At the end of the course students will be able to -

CO1: Transmission network of a power system and its peripheral parameters of control

CO2: Brief Introduction of power devices and its characteristics to aid the control of power system parameter.

CO3: Different configuration of Converter systems.

CO4: The concept of shunt compensation and to implement in a power system

CO5: The concept of series compensation and to implement in a power system

TEXT BOOKS:

1.Understanding Facts - Concepts and technology of flexible AC Transmission system, N.G.Hungorian& Laszlo Gyugyi IEEE Press, standard publisher, 2001.

REFERENCE BOOK/WEBSITE LINKS:

1.EHV - AC, HVDC Transmission & Distribution Engineering,S.Rao, Khanna publishers, 3rd edition 2003.

2.FACTS - Controllers in Power Transmission distribution- K.R. Padiyar - New age publishers - 2007.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 3and 4 and questions 5 and 6 are to be from unit 3 and unit 4 respectively. Students have to answer Q.3 or Q.4 and Q.5 or Q.6.

3. Questions 1, 2 and 7 are to be set from units 1, 2 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*			*						*
CO2	*	*								*		*
CO3	*	*	*	*	*		*			*		*
CO4	*	*	*	*	*		*			*		*
CO5	*	*	*	*	*		*			*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : ENERGY AUDITING & DEMAND SIDE MANAGEMENT		
Course Code : EE732	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1.To Understand basics of demand side management and mechanisms (technical, legal or financial) that influence energy consumption

2. To recognize opportunities for increasing rational use of energy and basics of energy auditing with application on different sectors.

Unit No.	Syllabus Content	No. of Hours
1	**INTRODUCTION**: Energy Situation – World And India, Energy Consumption, Conservation, Codes, Standards And Legislation.	07
2	**ENERGY ECONOMIC ANALYSIS:** The Time Value Of Money Concept, Developing Cash Flow Models, Payback Analysis, Depreciation, Taxes And Tax Credit – Numerical Problems.	07
3	**ENERGY AUDITING:** Introduction, Elements Of Energy Audits, Energy Use Profiles, Measurements In Energy Audits, Presentation Of Energy Audit Results. **ELECTRICAL SYSTEM OPTIMIZATION:** The Power Triangle, Motor Horsepower, Power Flow Concept.	09
4	**ELECTRICAL EQUIPMENT AND POWER FACTOR** – Correction & Location Of Capacitors, Energy Efficient Motors, Lighting Basics, Electrical Tariff, Concept Of ABT.	07
5	**DEMAND SIDE MANAGEMENT:** Introduction To DSM, Concept Of DSM, Benefits Of DSM, Different Techniques Of DSM – Time Of Day Pricing, Multi-Utility Power Exchange Model, Time Of Day Models For Planning, Load Management, Load Priority Technique, Peak Clipping, Peak Shifting, Valley Filling, Strategic Conservation, Energy Efficient Equipment. Management And Organization Of Energy Conservation Awareness Programs.	09

Course Outcome: At the end of the course students will be able to -
CO1: Understand the Energy situation in India and world Scenarios.

CO2: understand the Energy Economic analysis and develop cash flow models.

CO3: Study methods of energy accounting and energy auditing in energy sector, industry and final consumption. Finding opportunities to increase the rational use of energy.

CO4:Study of Electric Equipment and Power factor Correction methods

CO5: Familiarize with Demand side management, especially with management in energy sector engineering and Fundamentals of product strategy management.

TEXT BOOKS:

1. Industrial Energy Management Systems, Arry C. White, Philip S. Schmidt, David R. Brown, Hemisphere Publishing Corporation, New York.

2. Fundamentals of Energy Engineering - Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey.

3. Electrical Power distribution, A S. Pabla, TMH, 5th edition, 2004

4. Energy auditing and demand side management, Ajjanna, Gouthami publications,Shimaoga

REFERENCE BOOK/WEBSITE LINKS:

1. Recent Advances in Control and Management of Energy Systems, D.P.Sen, K.R.Padiyar, IndraneSen, M.A.Pai, Interline Publisher, Bangalore, 1993.

2. Energy Demand – Analysis, Management and Conservation, Ashok V. Desai, Wiley Eastern, 2005.

3. Demand Side Managementm, Jyothi Prakash, TMH Publishers.

4. Hand book on energy auditing - TERI (Tata Energy Research Institute)

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.
2: Questions 3 and 4 and questions 6 and 7 are to be from unit 3 and unit 5 respectively. Students have to answer Q.3 or Q.4 and Q.6 or Q.7.
3. Questions 1, 2 and 5 are to be set from units 1, 2and 4 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*			*	*			*		*
CO2	*	*	*			*	*			*		*
CO3	*	*	*			*	*			*		*
CO4	*	*	*			*	*			*		*
CO5	*	*	*			*	*			*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : POWER SYSTEM DYNAMICS AND STABILITY		
Course Code : EE733	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. **Introduction to** basic concepts of power system dynamics and stability. Review of classical methods, **system modeling, and dynamics of synchronous generator.**
2. Types of excitation and controllers, prime movers, SMIB, Transient stability evaluation and controllers.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction:** basic concepts of power system dynamics and stability. Review of classical methods. **System modeling and dynamics of synchronous generator:** modeling of synchronous machine, swing equation, park's transformation – park's voltage equation, park's mechanical equation (torque). Applications – (a) voltage build up in synchronous machine, and (b) Symmetrical short circuit of generator.	12
2	**Excitation and prime mover controllers:** introduction, types of excitation, AVR with and without ESS, TGR, amplifier PSS, static exciters.	10
3	**Modeling of prime movers:** introduction, three major components, block diagram, hydraulic turbine, and steam turbine.	10
4	**Load modeling:** introduction, polynomial model and exponential model. Small signal angle stability: small signal angle stability with SMIB system, detailed model of SMIB.	11
5	**Transient stability analysis:** simulation for transient stability evaluation, transient stability controllers.	09

Course Outcome: At the end of the course students will be able to -

CO1: model and analyze the synchronous generator under dynamic condition.
CO2:analyse problems related to excitation system and prime mover controllers of synchronous generator
CO3: model and analyze electrical load for different stability studies.
CO4: apply simulation techniques for analysis of transient stability studies.
CO5: evaluate the condition of stability of power system using different methods

TEXT BOOKS:

1) Power System Dynamics, Stability and Control, Padiyar K.R., Interline Publications.
2) Power System Stability and Control, Prabha Kundur. TMH, 9th Reprint.
3) Computer Techniques in Power System, Uma Rao, IK International Publishing House pvt. Ltd., Bangalore

REFERENCE BOOK/WEBSITE LINKS:

1) Dynamics and Control of Large Electric Power Systems, Marija Ilic; John Zaborszky, , IEEE Press and John Wiley & Sons, Inc, 2007
2) Power System Control and Stability Revised Printing, Paul M. Anderson and A. A. Fouad, IEEE Press and John Wiley & Sons, Inc, 2002.
3) Selected topics from IEEE Transaction and Conference Proceedings

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.
2: Questions 1 and 2 and questions 6 and 7 are to be from unit 1 and unit 5 respectively. Students have to answer Q.1 or Q.2 and Q.6 or Q.7.
3. Questions 3, 4 and 5 are to be set from units 2, 3 and 4 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*						*		
CO2	*	*		*						*		
CO3	*	*		*						*		
CO4	*	*		*	*							
CO5	*	*		*						*		

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : EMBEDDED SYSTEMS		
Course Code : EE734	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

4. Understand embedded system and real time systems.
5. Real-time systems: Identify the unique characteristic, explain general structure and define the unique design problems and challenges of real-time system
6. Understand basics, program, design, implement and test an embedded system.

Unit No.	Syllabus Content	No. of Hours
1	**Concept of Embedded System Design:** Components, classification, skills required. Embedded Micro controller cores, Architecture of 6808 and 6811. Embedded Memories ROM variants and RAM. Applications of embedded system: Examples of Embedded systems SOC for cell less bar code scanner.	12
2	**Technological Aspects of Embedded System:** Interfacing between analog and digital blocks, Signal conditioning, digital signal processing, DAC & ADC interfacing, Sample & hold, multiplexer interface Internal ADC interfacing (excluding 6805 & 6812), Signal conditioning using DSP.	10
3	**Design Trade Offs Due to Process Incompatibility, Thermal Considerations:** Issues in embedded system design. Design challenge, design technology, tradeoffs. Thermal considerations.	10
4	**Software aspects of Embedded Systems**: Real time programming Languages, operating systems. Programming concepts and embedded programming in C. Round Robin, Round Robin with interrupts, function queue-scheduling architecture, Real time OS architecture, selecting architecture. Introduction to RTOS.	11
5	**Subsystem interfacing**: External system, user interfacing and Serial I/O devices, Parallel port interfaces: Input switches, Key boards and Memory interfacing. **Case Study:** Embedded velocity PID controller, PI controller with a PWM actuator.	09

Course Outcome: At the end of the course students will be able to -
CO1: To learn the concept of embedded microcontroller cores, architecture and application of embedded system.

CO2: To understand technological aspects of interfacing between analog and digital blocks.

CO3: Embedded system design issues in compatibility are to be understood.

CO4: To learn the method of designing a real time system.

CO5: To learn the technological hardware of embedded system aspects.

TEXT BOOKS:

4. Embedded Microcomputer systems: Real time interfacing.Valvano, J.W, Cengage Learning, 2nd Edition 5th Indian reprint,2009
5. The Art of Designing Embedded Systems. Ganssle, Jack, Newness
6. Embedded System, Architecture, Programming and Design. Raj Kamal, TMH, 2nd Edition 2008.

REFERENCE BOOK/WEBSITE LINKS:

1A Unified Hardware/Software Introduction. Frank Vahid/Tony Givargis, Wiley student edition 2002
2Motorola and Intel Manuals

3Embedded Software Premier. Simon David, Addison Wessly 2000

INSTRUCTIONS TO PAPER SETTERS
1: Students have to answer five full questions of 20 marks each.
2: Questions 2 and 3 and questions 5 and 6 are to be from unit 2 and unit 4 respectively. Students have to answer Q.2 or Q.3 and Q.5 or Q.6.
3. Questions 1, 4 and 7 are to be set from units 1, 3 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*										
CO2			*	*	*							
CO3					*		*					
CO4									*	*		
CO5											*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : FUZZY LOGIC		
Course Code : EE735	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. Provide an emphasis on the differences and similarities between fuzzy sets and classical sets theories and understanding of the basic mathematical elements of fuzzy sets.
2. Emphasis on fuzzy logic inference with premise on fuzzy proposition
3. provide an introduction to fuzzy linear and non –linear controller design
4. Provide an insight into structure and design of adaptive controller.
5. Apply fuzzy inference in the area of process control and real time applications.

Unit No.	Syllabus Content	No. of Hours
1	**THE MATHEMATICS OF FUZZY CONTROL:** Fuzzy sets, properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, the extension principle.	07
2	**THEORY OF APPROXIMATE REASONING:** Linguistic variables, Fuzzy proportions, Fuzzy if- then statements, inference rules, compositional rule of inference.	07
3	**NON-LINEAR FUZZY CONTROL:** FKBC as a linear transient element, PID like FKBC, sliding mode FKBC, Sugeno FKBC.	07
4	**FUZZY KNOWLEDGE BASED CONTROLLERS (FKBC):** Basic concept structure of FKBC, choice of membership functions, scaling factors, rules, fuzzyfication and defuzzyfication procedures. Simple applications of FKBC (washing machines, traffic regulations, lift control, aircraft landing Control etc.).	09
5	**ADAPTIVE FUZZY CONTROL:** Process performance monitoring, adaption mechanisms, membership functions, tuning using gradient descent and performance criteria. Set organizing controller model based controller.	09

Course Outcome: At the end of the course students will be able to -

CO1: Be able to distinguish between the crisp set and fuzzy set concepts.

CO2: Be able to define fuzzy sets using linguistic variables and represent these sets by membership functions.

CO3: Become knowledgeable of conditional fuzzy propositions and fuzzy inference systems

CO4: Become aware of the use of fuzzy inference systems in the design of controllers.

CO5: Become aware of the application of fuzzy inference in the area of process control.

TEXT BOOKS:

1. Fuzzy Logic With Engineering Applications-TimotyRoss, John Wiley, Second Edition, 2009.

2. Fuzzy Sets Uncertainty and Information- G. J. Klir and T. A. Folger, PHI IEEE, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. An Introduction to Fuzzy Control, D. Diankar, H. Hellendoom and M. Reinfrank,Narosa

Publishers India, 1996.

2. Essentials of Fuzzy Modeling and Control, R. R. Yaser and D. P. Filer, John Wiley, 2007.

3. Fuzzy Logic Intelligence Control And Information, Yen- Pearson education, First Edition, 2006

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 3 and 4 and questions 5 and 6 are to be from unit 3 and unit 4 respectively. Students have to answer Q.3 or Q.4 and Q.5 or Q.6.

3. Questions 1, 2 and 7 are to be set from units 1, 2 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*									
CO2	*	*	*	*								
CO3			*	*								
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : ARTIFICIAL NEURAL NETWORK		
Course Code : EE736	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To organize the structural components.
2. Computation methodology needed for information extraction and storage.
3. Perform computation through learning algorithms.
4. Optimization techniques.

Unit No.	Syllabus Content	No. of Hours
1	Introduction, history, structure and function of single neuron, neural net architectures, neural learning, use of neural networks. Supervised learning, single layer networks, perceptrons, linear separability, perception training algorithm, guarantees of success, modifications.	10
2	Multiclass networks-I, multilevel discrimination, back propagation, setting parameter values, theoretical results. Accelerating learning process, application, and Madaline adaptive multilayer networks.	12
3	Prediction networks, radial basis functions, polynomial networks, regularization, unsupervised learning, winner-take-all networks. Learning vector quantizing, counter propagation networks, adaptive resonance theorem, topologically organized networks, distance based learning, recognition.	12
4	Associative models, Hop Field networks, brain state networks, Boltzmann machines, hetero associations.	09
5	Optimization using Hopfield networks, simulated annealing, random search, evolutionary computation.	09

Course Outcome: At the end of the course students will be able to -

CO1: Need of neural networks and its various realizations.

CO2: Analysis of neural networks various functional blocks with multiple inputs and outputs information.

CO3: Programming issues with application of neural networks to single input single output system.

CO4: Application of neural networks to multi input multi output system.

CO5: Salient features of input data mining and Realization of Hybrid systems.

TEXT BOOKS:

1. Elements Of Artificial Neural Networks -KishanMehrotra, C. K. Mohan, Sanjay Ranka, Penram, 1997

2. Artificial Neural Networks- R, Schalkoff, McGraw Hill, 1997.

REFERENCE BOOK/WEBSITE LINKS:

1. Neural Network Design- Hagan, Demuth and Beale Cengage,2nd Edition
2. Introduction To Artificial Neural Systems- J. Zurada, Jaico, 2003
3. Neural Networks - Haykins, PHI, 1999.
4. Artificial Neural Networks, B.Yegnanarayana, PHI, 2009 Edition

https://onlinecourses.nptel.ac.in

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.

3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*									
CO2	*	*	*	*								
CO3			*	*								
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMSTER		
Course Title : ELECTRICAL POWER QUALITY		
Course Code : EE737	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:students learn
1. Use of power electronic components in power system, power quality problems and affects all connected electrical and electronic equipment,
2. Power quality problems of electrical machines and power systems.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction**, power quality-voltage quality, power quality evaluation procedures term and definitions: general classes of power quality problems, transients, long duration voltage variation, short duration voltage variations, voltage imbalance, waveform distortion, power quality terms. **Voltage sags and interruptions:** sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, motor starting sags.	09
2	**Transient over voltages:** sources of transient over voltages, principles of over voltages protection, utility capacitor switching transients, fundamentals of harmonics: harmonic distortion, voltage versus transients, harmonic indexes, harmonic sources from commercial loads, harmonic sources from industrial loads, effects of harmonic distortion, intra-harmonics.	07
3	**Applied harmonics:** harmonic distortion evaluations, principles for controlling harmonics, harmonic studies, devices for controlling harmonic distortion, harmonic filters, standards of harmonics	07
4	**Power quality benchmark:** introduction, benchmark process, power quality contract, power quality state estimation, including power quality in distribution planning. **Distributed generation and quality**: DG technologies, interface to utility system, power quality issues, interconnection standards.	09
5	**Power quality monitoring:** monitoring considerations, power quality measurement equipments, assessment of power quality measurement data, application of intelligent systems, power quality monitoring standards.	07

Course Outcome: At the end of the course students will be able to -

CO1: Identify the causes and effects of power quality problems such as non-sinusoidal wave shapes, voltage outages, harmonic losses, origins of single-time events such as voltage dips, voltage reductions, and outages.

CO2: Adopt different techniques to mitigate the power quality problems.

CO3: Have a knowledge of guidelines and standards as well as industry regulations and practices for solving power quality problems in a cost-effective manner.

CO4: Have knowledge of estimating the power quality

CO5: Monitor the power quality using different techniques

TEXT BOOKS:

1.Electric Power Quality,Dugan, Roger C, Santoso, Surya, McGranaghan, Mark F/ Beaty, H. Wayne McGraw-Hill professional publication 2003.

REFERENCE BOOK/WEBSITE LINKS:

1. Electric Power Quality, G.T.Heydt, stars in a circle publications 1991.
2. Modern Power Electronics, M.H.Rashid TATA McGraw Hill 2002.
3. Understanding power quality problems voltage sags and interruptions- Math H. J. Bollen. IEEE Press, 2000
4. Power quality in power systems and electrical machines, Ewald F Fuchs, Mohammad A.S., Masoum, academic Press, Elsevier, 2009.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 6 and 7 are to be from unit 1and unit 5 respectively. Students have to answer Q.1 or Q.2 and Q.6 or Q.7.

3. Questions 3, 4 and 5 are to be set from units 2, 3 and 4 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*						*		
CO2	*	*		*						*		
CO3	*	*		*						*		
CO4	*	*		*						*		
CO5	*	*		*						*		

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title: ADVANCED POWER ELECTRONICS		
Course Code : EE738	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. DC-DC circuit topologies analysis and operation.
2. Switching strategy and converter topologies for high frequency applications.
3. Design of high frequency magnetics.
4. Switching power supplies with electrical isolation for different power applications.

Unit No.	Syllabus Content	No. of Hours
1	**DC-DC SWITCHED MODE CONVERTERS:** Topologies, buck, boost, buck-boost, and cuk converters, full bridge DC-DC converter-detailed theory, working principles, modes of operation, with detailed circuits and wave forms, applications, merits and demerits	12
2	**DC-AC SWITCHED MODE INVERTERS:** Single-phase inverters, three phase inverters. SPWM inverter, detailed theory, working principles, modes of operation with circuit analysis, applications, merits and demerits, problems based on input output voltage relationship	11
3	**RESONANT CONVERTERS**: Zero voltage and zero current switching, resonant switch converters, and comparison with hard switching, switching locus diagrams, and working principle.	10
4	**HIGH FREQUENCY INDUCTOR AND TRANSFORMERS**: Design principles, definitions, comparison with conventional design and problems. Design of fly back transformer.	09
5	**POWER SUPPLIES**: Introduction, DC power supplies: fly back converter, forward converter, push-pull converter, half bridge converter, full bridge converter, AC power supplies: switched mode ac power supplies, resonant ac power supplies and bidirectional ac power supplies.	10

Course Outcome: At the end of the course students will be able to -
CO1: Name different power conversion topologies and it's with its auxiliary devices.
CO2: Discuss the various functional blocks with single inputs and multi outputs power supplies.
CO3: Evaluation of various control techniques
CO4: Analyze various components for high frequency applications.
CO5: Design power converters for various applications.

TEXT BOOKS:

1. **Power Electronics,** Daniel .W. Hart, TMH, First Edition, 2010.
2. **Power Electronics - converters, application & design**, Mohan N, Undeland T.M., Robins, W.P, John Wiley ,3rd Edition 2008
3. **Power Electronics-Circuits, Devices, Applications,** Rashid M.H., PHI, 3rd Edition, 2008.

REFERENCE BOOK/WEBSITE LINKS:

1. **Power Electronics Essentials and Applications**, L. Umanand, Wiley India Pvt Ltd,Reprint,2010
2. **Modern Power Electronics and A.C. Drives,** Bose B.K, PHI, 2009.
3. **Digital Power Electronics and Applications,** Muhammad Rashid, Elsevier, first edition, 2005.
4. **Power Electronics, Devices, Circuits and Industrial Applications** ,V.R.Moorthi,Oxford,7th impression,2009

https://onlinecourses.nptel.ac.in

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 3 and 4 are to be from unit 1 and unit 2 respectively. Students have to answer Q.1 or Q.2 and Q.3 or Q.4.

3. Questions 5, 6 and 7 are to be set from units 3, 4 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*								
CO2	*		*	*							*	
CO3			*	*	*					*		
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: MODERN POWER SYSTEM PROTECTION		
Course Code : EE81	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 26+26

Course Objective:
1. To learn conventional and modern protection devices to protect power systems.
2. To introduce protection philosophy and embedded protection systems.
3. To study protection of power systems through Phasor Measurement technique.
4. To introduce different International Standards related to relaying.

Unit No.	Syllabus Content	No. of Hours
1	**Fuses:** Introduction to fuse**,** fuse law, cut -off characteristics, Time current characteristics, fuse material, HRC fuse, liquid fuse, applications of fuse. **Circuit Breakers – Operating principles:** Introduction, requirement of a circuit breakers, basic principle of operation of a circuit breaker, properties of arc, initiation and maintenance of arc, arc interruption theories -Slepian's theory and energy balance theory**,** Restriking voltage, recovery voltage, Rate of rise of restriking voltage, AC circuit breaking, current chopping, capacitance switching, resistance switching, Rating of Circuit breakers. **Circuits Breakers – Types & Construction:** SF_6 breaker, Puffer and non Puffer type of SF_6 breakers. Vacuum circuit breakers - principle of operation and constructional details. Advantages and disadvantages of different types of Circuit breakers.	5+4
2	**Protective Relaying Operating principles:** Requirement of Protective Relaying, Zones of protection, primary and backup protection, Essential qualities of Protective Relaying, Evolution of protective relays – Historical perspective, Classification of Protective Relays, A concise introduction to electromechanical relays, static relays and microprocessor based relays. **Protection philosophies:** Understanding of protection philosophies (the Physics of protection) as applicable to the unit protected - such as non-pilot over-current protection of transmission lines, transformer protection, non-pilot distance protection of transmission lines, rotating machinery protection.	4+5
3	**Embedded protection systems:** General architecture & Essential requirements of an embedded protection system – metering, protection, automation and control modules; model/component based approach in designing an embedded system; choice of OS, microprocessor architecture and digital signal processor architecture & requirements of – DMA, ADC, MAC, memory, communication controllers. Modeling formalism using UML – formal representation of requirements, temporal and spatial modeling techniques, use of finite-automata in designing of sequential control algorithms.	7+7

4	**Phasor measurement, metering and records (DSP techniques):** Definition of a phasor; DSP primer: simultaneity in sampling, sampling theorem, aliasing, DFT, digital filters – FIR, IIR, symmetric FIR filters, transform pairs and sync function, design of high pass and low pass filters; Phasor measurement algorithm; Spectral leakage and frequency tracking algorithms; Disturbance records and recorders; Introduction to synchro-phasor measurement.	6+6
5	**Substation Automation Concepts & Communication stacks:** Introduction to substation communication architecture; Quasi real time and real time communication requirements; Choice of physical layer based on the bandwidth requirements – RS-485, IEEE 802.3; Evolution of communication stacks and standards – MODBUS, IEC 60870-5-103, DNP 3.0, IEC 61850. A brief introduction to MODBUS; A brief introduction to IEC 61850.	4+4

Course Outcome: At the end of the course students will be able to -
CO1: define and explain various protection devices and protection schemes.
CO2: explain the characteristics and working of various protective devices and protection schemes.
CO3: apply the basic concepts of protection systems to solve problems related to protective relaying.
CO4: analyze various protection devices and protection techniques for application to protection systems.
CO5: justify the use of various international standards related to protective Relaying.

TEXT BOOKS / REFERENCE BOOK:
1.Power system relaying: Stanley H. Horowitz & Arun G. Phadke, Wiley, 3rd edition.
2. Power system protection and switchgear: Bhuvanesh Oza, et.al,, Mc Graw Hill Publication, New Delhi
3. Computer relaying for power systems: Arun G. Phadke & James S. Thorp, Wiley, 2nd edition
4.**Switchgear & Protection:** Sunil S.Rao, Khanna Publishers, 13th Edition, 2008.
5.**Power System protection static relays with microprocessor applications:TS Madava rao, TMH second edition, 2004.**

INSTRUCTIONS TO PAPER SETTERS
1: Students have to answer five full questions of 20 marks each.
2: Questions 3 and 4 and questions 5 and 6 are to be from unit 3 and unit 4 respectively. Students have to answer Q.3 or Q.4 and Q.5 or Q.6.
3. Questions 1, 2 and 7 are to be set from units 1, 2 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*	*	*					*
CO2	*	*	*	*	*	*	*					*
CO3	*	*	*	*	*	*	*					*
CO4	*	*	*	*	*	*	*					*
CO5	*	*	*	*	*	*	*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: POWER SYSTEM OPERATION AND CONTROL		
Course Code : EE82	No. of Credits:3; L:T:P - 2:1:0	No. of hours/week: 2+2
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1. To impart knowledge relevant to power system planning and operations.
2. To learn network operation, generation and transmission planning.
3. To provide an insight into elaborate concepts of Automatic Generation control for Load frequency.
4. Power system security issues and Contingency analysis.

Unit No.	Syllabus Content	No. of Hours
1	**Control center operation of power systems :** Introduction to SCADA, control center, digital computer configuration, automatic generation control, area control error, operation without central computers, parallel operation of generators.(Problems on parallel operation only)	7
2	**Automatic Generation Control:** Introduction, Load Frequency Control (single area case) Turbine speed governing system Model of speed Governing system, Turbine model, Block diagram of Load frequency control of an isolated power system. Control area concept, Proportional plus integral control, Load frequency control and Economic dispatch control, Two area load frequency control, Automatic voltage regulator.	8
3	**Control of Voltage and reactive power:** Introduction, generation and absorption of reactive power, relation between voltage, power and reactive power at a node, single machine infinite bus system, methods of voltage control, sub synchronous resonance, voltage stability, voltage collapse.	8
4	**Unit commitment:** statement of the problem, need and importance of Unit commitment, methods – priority list method, dynamic programming method (Flow chart only), constraints, spinning reserve, examples.	8
5	**Power system security:** Introduction, system state classification, Security analysis, factors affecting power system security, modeling for contingency analysis, contingency selection, contingency analysis, sensitivity factors.	8

Course Outcome: At the end of the course students will be able to -
CO1: Explain the important functions like SCADA, EMS, DMS etc., and issues involved in different activities associated with power system operation and planning.
CO2: Discuss load frequency control Techniques and methods of voltage and reactive power control.
CO3: Explain the need and Importance of unit commitment.
CO4: Analyze various Power System security issues under different operating conditions
CO5: Discuss the Recent trends in PSOC.

TEXT BOOKS:

1) Computer aided power system analysis, G L Kusic, PHI, 2010.
2) Modern Power System Analysis, I.J. Nagarath and D.P. Kothri,TMH, 2003
3) Power Generation, Operation & control, AJ Wood &Woolenburg, John Wiley & Sons, 2nd edition 2009.
4) Electric power Systems, B.M Weedy and B J Cory,
5) Electric Energy Systems,Olle J Elgerd, TMH, 2008

REFERENCE BOOK/WEBSITE LINKS:

1) Power System Stability and Control, Prabha Kundur,TMH,1993
2) Operation and control in Power Systems, PSR Murthy,B S Publications, 1998
3) Power system analysis, operation and Control, AbhijitChakrabarti, SunitaHaldar, PHI, 2nd edition 2009.
4) Power system analysis, operation and Control, S Shivaganaraju& G Sreenivasan, Pearson 2010
5) Power System operation, Robert H Miller & James H Malinowski, TMH 3rd edition 2009

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 2 and 3 and questions 4 and 5 are to be from unit 2 and unit 3 respectively. Students have to answer Q.2 or Q.3 and Q.4 or Q.5.

3. Questions 1, 6 and 7 are to be set from units 1, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*									
CO2			*	*		*						
CO3				*		*	*		*			
CO4									*	*		
CO5											*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: TESTING & COMMISSIONING OF ELECTRICAL EQUIPMENT		
Course Code : EE831	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. Proper testing and commissioning promote long-term efficient operation of electrical generation and delivery systems.
2. Aim of the subject is to expose to testing on each piece of equipment and then commissioning.

Unit No.	Syllabus Content	Hours
1	**TRANSFORMERS:** **a. Specifications:** Power and distribution transformers as per BIS. **b. Installation:** Location, site, selection, foundation details (like bolts size, their number, etc.), code of practice for terminal plates, polarity & phase sequence, oil tanks, drying of windings and general inspection.	09
2	**TRANSFORMERS:** **a. Commissioning tests:** Following tests as per national & International Standards, volt ratio test, earth resistance, oil strength, Bucholz & other relays, tap changing gear, fans & pumps, insulation test, impulse test, polarizing index, load & temperature rise test. **b. Specific Tests:** Determination of performance curves like efficiency, regulation etc., and determination of mechanical stress under normal &abnormal conditions.	09
3	**SYNCHRONOUS MACHINES:** **a. Specifications:** As per BIS. **b. Installation:** Physical inspection, foundation details, alignments, excitation systems, cooling and control gear, drying out. **c. Commissioning Tests:** Insulation, Resistance measurement of armature & field windings, waveform & telephone interference tests, line charging capacitance. **d. Performance tests:** Various tests to estimate the performance of generator operations, slip test, maximum lagging current, maximum reluctance power tests, sudden short circuit tests, transient & sub transient parameters, measurements of sequence impedances, capacitive reactance, and separation of losses, temperature rise test, and retardation tests. **e. Factory tests:** Gap length, magnetic eccentricity, balancing vibrations, bearing performance.	12
4	**INDUCTION MOTORS:** a. **Specifications** for different types of motors, Duty, I.P. protection. **b. Installation:** Location of the motors (including the foundation details) & its control apparatus, shaft & alignment for various coupling, fitting of pulleys &	10

	coupling, drying of windings. **c. Commissioning Test:** Mechanical tests for alignment, air gap symmetry, tests for bearings, vibrations & balancing.	
5	**INDUCTION MOTORS:** **a. Electrical Tests:** Insulation test, earth resistance, high voltage test, starting up, failure to speed up to take the load, type of test, routine test, factory test and site test (in accordance with ISI code **b. Specific Tests:** Performance & temperature raise tests, stray load losses, shaft alignment, and re-rating & special duty capability. **SWITCH GEAR & PROTECTIVE DEVICES:** Standards, types, specification, installation, commissioning tests, maintenance schedule, type & routine tests.	12

Course Outcome: At the end of the course students will be able to -

CO1: Conduct acceptance test to ensure that each piece of electrical equipment meets specification, ready for energization and conforms to the drawings.

CO2: Certify that it will operate as designed and perform as an integral part of the system.

CO3: Verify the entire system, when commissioned and following tests, operates as intended and meeting design requirements.

CO4: Acquaint to the standards

CO5: More attention is being directed to the maintenance and safe operation of electrical equipment.

TEXT BOOKS:

1. Testing & Commissioning Of Electrical Equipment -S. Rao, Khanna Publishers,2004
2. Testing & Commissioning Of Electrical Equipment -B .V. S. Rao, Media Promoters and Publication Pvt., Ltd.

REFERENCE BOOK/WEBSITE LINKS:

1. Relevant Bureau of Indian Standards
2. A Handbook on Operation and Maintenance of Transformers- H. N. S. Gowda, Published by H. N. S.Gowda,2006
3. Handbook of Switchgears**,** BHEL, TMH, 2005. J and P Transformer Book, Elsevier Publication.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 3 and 4 and questions 6 and 7 are to be from unit 3 and unit 5 respectively. Students have to answer Q.3 or Q.4 and Q.6or Q.7.

3. Questions 1, 2 and 5 are to be set from units 1, 2and 4 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*			*	*			*		*
CO2	*	*	*			*	*			*		*
CO3	*	*	*			*	*			*		*
CO4	*	*	*			*	*			*		*
CO5	*	*	*			*	*			*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: HVDC TRANSMISSION		
Course Code : EE832	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. To learn the aspects of AC and DC transmission.
2. To analysis the components required for HVDC transmission.
3. To learn the methods of control and protection of HVDC converters and systems.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction :** Historical sketch, constitution of EHV AC and DC links, comparison of AC and DC transmission systems-technical, economics and reliability, advantages and disadvantages of HVDC transmission systems, applications of DC transmission systems, Types of HVDC links, block diagram of HVDC system.	8
2	**Converter circuits:** thyristor characteristics, description of uncontrolled rectifiers, controlled rectifiers: single phase rectifiers, three phase rectifiers, choice of best configuration for HV DC systems and two level voltage source inverter.	12
3	**Analysis of the bridge converter:** Analysis of six pulse converters with grid control and no overlap, Analysis of six pulse converters with grid control and overlap greater than and less than 60 degrees, analysis of twelve pulse converters complete characteristics of rectifier and inverter.	11
4	**Control of HVDC converters and systems:** grid control, basic means of control, power reversal, limitations of manual control, constant current versus constant voltage, desired feature of control, actual control characteristics, constant -minimum -ignition –angle control, constant –current control, constant –extinction –angle control, stability of control, tap changer control, power control.	12
5	**PROTECTION:** Introduction, DC reactor, surge arresters, over voltage protection, over current protection, voltage oscillations and valve dampers, current oscillations and anode dampers, DC line oscillations and line dampers, clear line faults and reenergizing the line.	09

Course Outcome: At the end of the course students will be able to -
CO1: recall and compare the different power transmission systems.
CO2: understand ideal requirements of HVDC transmission systems.
CO3: analysis the different converter circuits and select the suitable converter circuit for HVDC systems.
CO4: Analyze controllers for HVDC systems.
CO5: Understand the importance of protection and its requirements for HVDC systems.

TEXT BOOKS:
1. EW Kimbark, "Direct current Transmission"
2. Jos Arrillaga, Y.H.Liu and Mevelle R Watson, "High Voltage Power Transmission: The HVDC Options", Wiley Interscience.
3. K.R.Padiyar, "High Voltage D.C.Power Transmission System", New Age International Publishers Ltd.

INSTRUCTIONS TO PAPER SETTERS
1: Students have to answer five full questions of 20 marks each.
2: Questions 3 and 4 and questions 5 and 6 are to be from unit 3 and unit 4 respectively. Students have to answer Q.3 or Q.4 and Q.5 or Q.6.
3. Questions 1, 2 and 7 are to be set from units 1, 2 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*			*	*	*		*		*
CO2	*			*	*		*					
CO3	*	*	*	*								
CO4	*	*	*	*							*	
CO5	*		*	*		*	*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: INSULATION ENGINEERING		
Course Code : EE833	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. To introduce concepts of dielectric, dielectric stress in various electrical equipments.
2. To introduce dielectrics phenomena.
3. To analyze failure of dielectrics due to ageing mechanism.

Unit No.	Syllabus Content	No. of Hours
1	**Electrostatic Field, their Control and Estimations**: Electric Field Intensity, Electric Strength, Classification of Electric Fields, Degree of Uniformity of Electric Fields, control of Electric field Intensity (stress control), Estimation of Electric Field Intensity, Basic Equations for potential and Field Intensity in Electrostatic Fields.	11
2	**Insulation System in Power System Apparatus**: Insulation system in capacitors, bushings and transformers. Modes of failure of insulation systems. Insulations used in rotating machines.	09
3	**Dielectric Phenomena**: Dielectric phenomena in insulation – Permittivity and Loss Tangent. Phenomena of Polarization, depolarization, Relaxation in solids and liquids. Breakdown strengths of Dielectric Media**,** Influence of type of electrical excitation (AC, DC and Impulse), Physics of breakdown phenomena in vacuum gaps. Concept of self-restoring and non self – restoring insulation, enclosed and exposed insulation	11
4	**Gaseous Insulation:** Requirement of gaseous insulation. Breakdown processes: types of collision, Elastic and in-elastic, collision cross-section, Mobility of ions, Diffusion of charges, Emission of radiation and excitation, various secondary processes, Gas insulated substations. Overvoltage, Surge arrestors and insulation coordination	10
5	**Ageing Phenomena:** Failure of electric insulation due to ageing. Ageing mechanisms- Thermal ageing, Electrical ageing, combined thermal and electrical ageing. Analysis of insulation failure data, Power law model, Graphical estimation of power law constants, ageing data.	11

Course Outcome: At the end of the course students will be able to -
CO1: Solve electric field problems related to dielectrics.
CO2: To understand insulation/insulation systems used in power system apparatus
CO3: To understand the dielectric phenomena in insulation and influence of excitations.
CO4: To understand the concept of gaseous insulation, insulation coordination and influence of over voltages
CO5: Understand and analyze failure of insulation due to ageing.

TEXT BOOKS:

1. Methods of statistical analysis and life data. Hann N.R. Schafer R.E. and Singapore wall N.D. John Wiley and sons, New York, 2002.
2. High voltage Engineering fundamentals. E. Kufell and W.S. Zaengl, and J. Kufell, 2nd edition, Elsevier 2005
3. High voltage Engineering. M.S. Naidu and V Kamaraju, TMH, 4th edition, 2008.
4. Electrical insulation.Bradwell A. Peter Peregrinus Ltd, London, 1993.

REFERENCE BOOK/WEBSITE LINKS:

1. Electrical breakdown of gases. J.M. Meek and J.D. Craggs, "Oxford university press, 11953
2. Fundamentals of gaseous ionization and plasma electronics. Nasser E. John Wiley Interscience, New York, 1971.
3. Gas Insulated Substations. M.S. Naidu, I K International Publishing House, 2008 Edition.
4. High Voltage Insulation Engineering. Ravindra Arora, Wolfgang Mosch, New age International Publishers Ltd.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.
2: Questions 3 and 4 and questions 6 and 7 are to be from unit 3 and unit 5 respectively. Students have to answer Q.3 or Q.4 and Q.6 or Q.7.
3. Questions 1, 2 and 5 are to be set from units 1, 2 and 4 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*								*
CO2	*	*		*								*
CO3	*	*		*								*
CO4	*	*		*								*
CO5	*	*		*								*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: ADVANCED CONTROL SYSTEM		
Course Code : EE837	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To study digital control system and mathematical modeling.
2. To study the stability analysis of linear and non-linear systems.

Unit No.	Syllabus Content	No. of Hours
1	**Digital Control Systems:** Review of difference equations and Z - transforms, Z- transfer function (Pulse transfer function), Z - Transforms analysis, sampled data systems, Stability analysis (Jury's Stability Test and Bilinear Transformation), Pulse transfer functions and different configurations for closed loop Discrete-time control systems.	12
2	**Modern Control Theory:** State model for continuous time and discrete time systems, Solutions of state equations (for both continuous and discrete systems).	10
3	Concepts of controllability and observability (For both continuous and discrete systems), Pole Placement by state feedback (for both continuous and discrete systems), Full order and reduced order observes (for both continuous and discrete systems).	10
4	Dead beat control by state feedback, Optimal control problems using state variable approach, State Regulator and output regulator, Concepts of Model reference control systems, Adaptive Control systems and design.	10
5	**Non Linear Control Systems**: Common nonlinearities, Singular Points, Stability of nonlinear systems – Phase plane analysis and describing function analysis, Lyapunov‟s stability criterion, Popov‟s criterion.	10

Course Outcome: At the end of the course students will be able to -
CO1: Understand the fundamentals of state variables, linear and nonlinear systems.
CO2: Analyze SISO and MIMO systems and obtain the state models.
CO3: Analyze and design concepts of model reference and adaptive control systems.
CO4: Perform analysis on Controllability and Observability.
CO5: Improve stability of a given system by state feedback pole placement techniques

TEXT BOOKS:

1. Digital control & state variable methods. M. Gopal , 3rd Edition, TMH ,2008
2. Control system Engineering. I. J. Nagarath & M. Gopal, New Age International (P) Ltd, 3rd edition.

REFERENCE BOOK/WEBSITE LINKS:

1) Modern Control Engineering, Ogata. K., PHI, 4th Edition.
2) Discrete time Control Systems, Ogata K, PHI, 2nd Edition.
3) Control Systems Engineering, Nagarath and Gopal, Wiley Eastern Ltd.
4) Modem Control System Theory, M Gopal, Wiley Eastern Ltd.
5) Digital Control & State Variable Methods, M. Gopal, TMH, 2006

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.
2: Questions 1 and 2 and questions 6 and 7 are to be from unit 1 and unit 5 respectively. Students have to answer Q.1 or Q.2 and Q.6 or Q.7.
3. Questions 3, 4 and 5 are to be set from units 2, 3 and 4 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*								*		*
CO2	*	*				*				*		*
CO3	*	*				*				*		*
CO4	*	*				*				*		*
CO5	*	*				*				*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: COMPUTER CONTROL OF ELECTRIC DRIVES		
Course Code : EE835	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. Introduction to modern digital control of drives, different types of sensors and to study the concept of ac machine drives in detail.

2. To learn phase controlled converters, principles of slip power recovery schemes and to know about principle of Vector Control of AC Drives.

3. To learn about Applications of expert system to Drives.

Unit No.	Syllabus Content	No. of Hours
1	**Review of Micro Controllers in Industrial Drives System:** Typical Micro controller's 8 bit 16 bit (only block diagram) Digital Data Acquisition system, voltage sensors, current sensors, frequency sensors and speed sensors.	10
2	**AC Machine Drives:** general classification and National Electrical Manufacturer Association (NEMA) classification, Speed control of Induction motors with variable voltage constant frequency, constant voltage variable frequency, (v/f) constant operation, drive operating regions. Variable stator current operation. Effect of Harmonics.	11
3	**Phase Controlled Converters:** Converter controls, Linear firing angle control, cosine wave crossing control, and phase locked Oscillator principle, Electromagnetic Interference (EMI) and line power quality problems, cyclo converters, voltage fed converters, Rectifiers, and Current fed converters. **Principles of Slip Power Recovery Schemes**: Static Kramer's drive system, block schematic diagram, phasor diagram and limitations, Static Scherbins scheme system using D.C link converters with cyclo converter modes of operation, modified Scherbins Drive for variable source, constant frequency (VSCF) generation.	11
4	**Principle of Vector Control of AC Drives:** Phasor diagram, digital Implementation block diagram, Flux vector estimation, indirect vector control block diagram with open loop flux control, synchronous motor control with compensation.	10
5	**Expert System Application to drives (Only Block Diagram):** Expert system shell, Design methodology, ES based P-I tuning of vector controlled drives system, Fuzzy logic control for speed controller in vector control drives, structure of fuzzy control in feedback system.	10

Course Outcome: At the end of the course students will be able to -

CO1: Learn about Digital Data Acquisition System and all types of sensors in detail.

CO2: Understand the concept of AC Machine Drives operation and characteristics.

CO3: Know about different types of phase controlled converters.

CO4: Learn about digital implementation and principle of vector control of AC drives.

CO5: Learn design methodology of drives and fuzzy logic control feedback system.

TEXT BOOKS:

1. Power Electronics & Motor Drives. BimalK.Bose, Elsevier 2006
2. Modern Power Electronics & Drives. Bimal K. Bose, Pearson Education 2003.

REFERENCE BOOK/WEBSITE LINKS:

1. Advanced Microprocessor and Interfacing. Badri Ram, TMH, 1st Edition.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 2 and 3 and questions 4 and 5 are to be from unit 2 and unit 3 respectively. Students have to answer Q.2 or Q.3 and Q.4 or Q.5.

3. Questions 1, 6 and 7 are to be set from units 1, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*								*
CO2	*	*			*							*
CO3	*	*			*							*
CO4	*	*		*		*						
CO5	*	*										*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: ELECTROMAGNETIC COMPATIBILITY*		
Course Code : EE838	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. Learning concepts and overview of electromagnetic compatibility (EMC) and EMI that covers the history of EMI occurrence.
2. To understand the worldwide EMC regulatory requirements.
3. Discussion of behaviors of passive components at high frequencies and their impacts on EMC.
4. To understand Cabling, Grounding and Shielding Techniques.
5. To study Electrostatic discharge (ESD) and its effects.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction:** Designing for Electromagnetic compatibility. EMC regulations. Typical Noise path. Use of network theory. Methods of noise coupling miscellaneous noise sources. Methods of eliminating interference.	10
2	**Cabling:** Capacitive coupling. Effect of shield on capacitive coupling. Inductive coupling, mutual inductance calculations. Effect of shield on magnetic coupling. Magnetic coupling between shield and inner conductor. Shielding to prevent magnetic radiation, Shielding a receptor against magnetic fields, shield transfer impedance, coaxial cable versus shielded twisted pair, braided shields, effect of pigtails, ribbon cables. Electrically long cables	11
3	**Grounding:** Safety grounds, signal grounds single point ground systems hybrid grounds, multipoint ground systems, functional ground layout, practical low frequency grounding, hardware grounds, single ground reference for a circuit amplifier shields, grounding of cable shields, ground loops, and methods for breaking ground loops. Differential amplifiers shields, grounding at high frequency, guard shields and guarded meters.	11
4	**Shielding:** Near fields and far fields. Characteristic and wave impedance, shielding effectiveness, absorption loss, reflection loss, composite adsorption and reflection loss. Apertures, conductive gaskets, conductive windows, conductive coating, cavity resonance.	10
5	**Electrostatic discharges :** Static Generation, human body model, static discharge, ESD Protection in equipment design, software and ESD protection, ESD protection, ESD versus EMC	10

Course Outcome: At the end of the course students will be able to -
CO1: Explain and Understand EMC regulatory requirements in North America, European Community and Asia Pacific region.
CO2: Select proper passive components at high frequencies to minimize unwanted EMI behaviors.
CO3: Apply the correct grounding and shielding methodologies for specific product groups and operating frequencies.
CO4: Discuss non-linear phenomena and (ESD) with good design practices.
CO5: Discuss the basic setup for a product-under-test to meet a specific EMC standard.

TEXT BOOKS:

1) Noise Reduction Techniques in Electronic Systems, Henry W Otto, Second Edition John Wiley and Sons 1989.
2) Electromagnetic Compatibility Engineering, H W Otto, Wiley, Aug.2009

REFERENCE BOOK/WEBSITE LINKS:

5. Engineering Electromagnetic Compatibility, V Prasad Kodali, Wiley IEEE press, 2nd Edition, 2001
6. Introduction to Electromagnetic Compatibility, Clayton R Paul,WileyInterscience Publications,2nd edition,2006
7. www.autoemc.net
8. http://www.ofcom.org.uk/website/regulator-archives
9. www.fcc.gov/engineering-technology/electromagnetic-compatibility-division/radio-frequency-safety/faq/rf-safety

INSTRUCTIONS TO PAPER SETTERS
1: Students have to answer five full questions of 20 marks each.
2: Questions 2 and 3 and questions 4 and 5 are to be from unit 2 and unit 3 respectively. Students have to answer Q.2 or Q.3 and Q.4 or Q.5.
3. Questions 1, 6 and 7 are to be set from units 1, 4 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*		*		*	*	*		
CO2	*		*	*	*					*		
CO3	*	*	*	*			*			*		
CO4	*	*	*	*			*			*		
CO5	*	*	*	*	*	*	*			*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: ARTIFICIAL INTELLIGENCEAPPLICATIONS TO POWER SYSTEMS		
Course Code : EE834	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To give knowledge about Sparsity oriented Programming.
2. This course is an introduction to the basic concepts of Artificial Intelligence, with illustrations of current state of the art research and applications.
3. To have knowledge representation for the engineering issues underlying the design of AI systems.
4. To have a basic proficiency in a traditional AI language including an ability to write simple to intermediate programs and an ability to understand code written in that language.

To and blind and heuristic search, as well as an understanding of other topics such as minimax, resolution, etc. that play an important role in AI program.

Unit No.	Syllabus Content	No. of Hours
1	**Sparsity oriented Programming**: Introduction, physical structure and sparsity, pivoting, conservation of sparsity by optimal ordering of buses, schemes for ordering, UD table storage scheme.	**09**
2	**Artificial Intelligence:** What is AI? Definitions, history and evolution, essential abilities of intelligence, AI applications; Problem solving: problem characteristics, problem search strategies, forward and backward reasoning, AND-OR graphs, game trees, search methods- informed and uninformed search, breadth first search and depth first search methods	**09**
3	**Knowledge representation**: logical formalisms: propositional and predicate logic: syntax and semantics, wffs, clause form expressions, resolution- use of RRTs for proofs and answers, examples from electric power systems, Non-monotonic logic: TMS, modal, temporal and fuzzy logic.	**12**
4	**Structured representation** of knowledge: ISA/ISPART trees, semantic nets, frames and scripts, examples from electric systems. **Expert systems:** Basic components, forward and backward chaining, ES features, ES development, ES categories, ES tools and examples from electric drive systems.	**12**
5	**AI languages:** LISP and ProLog - Introduction, sample segments, LisP primitives, list manipulation functions, function predicates, variables, iteration and recursion, property lists, sample programs for examples from electric power systems.	**10**

Course Outcome: At the end of the course students will be able to -
CO1: Understand the basic issues of knowledge representation of Sparsity oriented programming.
CO2: Appreciation for and understanding of both the achievements of AI and the theory underlying those achievements.
CO3: Learn about knowledge representation on logical formalisms.
CO4: Promote and lead research in various aspects related to Intelligent Systems.
CO5: Cover a broad spectrum of AI concepts and methods and apply some of them in programming assignments.

TEXT BOOKS:

1) Introduction to Artificial Intelligence and Expert Systems, D.W.Patterson,PHI, 2009.
2) Computer Methods for Circuit Analysis and Design, J.Vlach and Singhal, CBS Publishers, 1986.
3) Artificial Intelligence, Rich, Elaine, Kevin Knight, TMH, 3rd Edition, 2008.
4) Introduction to AI, Charniak E. and Mcdermott D ,Pearson Education.
5) Problem Solving Methods in AI, Nils J.Nilson ,McGraw-Hill, 1971.
6) Principles of AI**,** Nils J.Nilson, Berlin Springer-Verlag, 1980

REFERENCE BOOK/WEBSITE LINKS:

INSTRUCTIONS TO PAPER SETTERS
1: Students have to answer five full questions of 20 marks each.
2: Questions 1 and 2 and questions 3 and 4 are to be from unit 1 and unit 2 respectively. Students have to answer Q.1 or Q.2 and Q.3 or Q.4.
3. Questions 5, 6 and 7 are to be set from units 3, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*					*			*		*	
CO2	*		*			*			*		*	
CO3			*			*						
CO4	*		*			*			*		*	
CO5			*			*			*		*	

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VIII SEMESTER		
Course Title: MICRO AND SMART SYSTEM TECHNOLOGY		
Course Code : EE836	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. Micro and smart system Technology involves the design, manufacture, and packaging of micro-electro -mechanical systems and peripherals for use in the aerospace, automotive, biotechnology, consumer products, defense, environmental protection and safety, healthcare, pharmaceutical, and telecommunications industries etc.
2. The objective of this multidisciplinary course is to provide necessary fundamental knowledge and experience in the design, manufacture, and packaging of Microsystems.

Unit No.	Syllabus Content	No. of Hours
1	**INTRODUCTION TO MICRO AND SMART SYSTEMS:** a) What are smart-material systems? Evolution of smart materials, structures and systems. Components of a smart system. Application areas. Commercial products. b) What are Microsystems? Feynman's vision. Micro machined transducers. Evolution of micro-manufacturing. Multi-disciplinary aspects. Applications areas. Commercial products. **MICRO AND SMART DEVICES AND SYSTEMS: PRINCIPLES AND MATERIALS:** a) Definitions and salient features of sensors, actuators, and systems. b) Sensors: silicon capacitive accelerometer, Piezo-resistive pressure sensor, blood analyzer, conductometric gas sensor, fiber-optic gyroscope and surface-acoustic-wave based wireless strain sensor. c) Actuators: silicon micro-mirror arrays, Piezo-electric based inkjet print-head, electrostatic comb-drive and micromotor, magnetic micro relay, shape-memory-alloy based actuator, electro-thermal actuator d) Systems: micro gas turbine, portable clinical analyzer, active noise control in a helicopter cabin	**12**
2	**MICROMANUFACTURING AND MATERIAL PROCESSING:** a) Silicon wafer processing, lithography, thin-film deposition, etching (wet and dry), wafer-bonding, and metallization. b) Silicon micromachining: surface, bulk, molding, bonding based process flows. c) Thick-film processing: d) Smart material processing: e) Processing of other materials: ceramics, polymers and metals f) Emerging trends **MODELING:** a) Scaling issues. b) Elastic deformation and stress analysis of beams and plates. Residual stresses and stress gradients. Thermal loading. Heat transfer issues. Basic fluids issues. c) Electrostatics. Coupled electromechanics. Electromagnetic actuation. Capillary electro-phoresis. Piezoresistive modeling. Piezoelectric modeling. Magnetostrictive actuators.	**12**
3	**COMPUTER-AIDED SIMULATION AND DESIGN:** Background to the finite element method. Coupled-domain simulations using Matlab. Commercial software.	**09**
4	**ELECTRONICS, CIRCUITS AND CONTROL:** Carrier concentrations, semiconductor diodes, transistors, MOSFET amplifiers, operational amplifiers. Basic Op-Amp circuits. Charge-measuring circuits. Examples from microsystems. Transfer function, state-space modeling, stability, PID controllers, and model order reduction. Examples from smart systems and micro machined accelerometer or a thermal cycler.	**09**

5	**INTEGRATION AND PACKAGING OF MICROELECTRO MECHANICAL SYSTEMS:** Integration of microelectronics and micro devices at wafer and chip levels. Microelectronic packaging: wire and ball bonding, flip-chip. Low-temperature-cofired-ceramic (LTCC) multi-chip-module technology. Microsystem packaging examples. **CASE STUDIES:** BEL pressure sensor, thermal cycler for DNA amplification, and active vibration control of a beam.	**10**

Course Outcome: At the end of the course students will be able to -

1. Describe fundamentals and design principles.
2. Describe modeling techniques and fabrication methods.
3. Perform computer-aided simulation and design.
4. Describe applications of smart systems.
5. Integrate microelectronics and micro-devices at wafer and chip level.

TEXT BOOKS:

1) **MEMS & Microsystems: Design and Manufacture,** Tai-Ran Hsu, TMH, 1st Edition.
2) **Micro and Smart Systems** by Dr. A.K.Aatre, Prof. Ananth Suresh, Prof.K.J.Vinoy, Prof. S. Gopalakrishna,, Prof. K.N.Bhat.,John Wiley Publications

REFERENCE BOOK/WEBSITE LINKS:

1) **Animations of working principles, process flows and processing techniques**, A CD-supplement with Matlab codes, photographs and movie clips of processing machinery and working devices.
2) **Laboratory hardware kits for** (i) BEL pressure sensor, (ii) thermal-cycler and (iii) active control of a cantilever beam.
3) **Microsystems Design,** S. D. Senturia, 2001, Kluwer Academic Publishers, Boston, USA.ISBN **0**-7923-7246-8.
4) **Analysis and Design Principles of MEMS Devices,** Minhang Bao, Elsevier, Amsterdam, The Netherlands, ISBN 0-444-51616-6.

Design and Development Methodologies,Smart Material Systems and MEMS, V. Varadan, K. J. Vinoy, S. Gopalakrishnan, Wiley.

MEMS- Nitaigour Premchand Mahalik, TMH 2007

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 3 and 4 are to be from unit 1 and unit 2 respectively. Students have to answer Q.1 or Q.2 and Q.3 or Q.4.

3. Questions 5, 6 and 7 are to be set from units 3, 4 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*			*			*				*	
CO2	*			*			*				*	
CO3	*			*			*				*	
CO4	*			*			*				*	
CO5	*			*			*				*	

Panchajanya Vidya Peetha Welfare Trust (Regd)
Dr. Ambedkar Institute of Technology
Aided by Govt. of Karnataka, An Autonomous Institution, Affiliated to Visvesvaraya Technological University, Belagavi, Approved by All India Council for Technical Education (AICTE), New Delhi, Accredited by NBA and NAAC with 'A' Grade
BDA Outer Ring Road, Mallathahalli, Bengaluru - 560 056

Ref. No. ....   Date : 05.01.2023

2017-18

Subjects focusing on Employability/Entrepreneurship/Skill development for the year

S.No	Subject Code	Subject
1.	EE31	Analog Electronic Circuits
2.	EE34	Transformer and Induction Machines
3.	EEL35	Electronic Circuits Lab
4.	EE41	Microcontrollers
5.	EE42	Control Systems
6.	EE45	Generation, Transmission & Distribution
7.	EEL46	Microcontroller Lab
8.	EEL47	Transformer and Induction Machines Lab
9.	EE51	Signals and Systems
10.	EE52	Power Electronics II
11.	EE53	DC Machines & Synchronous Machines
12.	EEL56	Control Systems Lab
13.	EEL57	Power Electronics – II Lab
14.	EE553	Linear IC's and Applications
15.	EE61	Power Systems Analysis
16.	EE62	Electrical Machine Design
17.	EE63	Digital Signal Processing
18.	EEL66	DC Machines & Synchronous Machines Lab
19.	EEL67	Digital Signal Processing Lab
20.	EE643	Programmable Logic Controllers
21.	EE652	Special Machines
22.	EE72	High Voltage Engineering
23.	EE734	Embedded Systems
24.	EE735	Fuzzy Logic
25.	EE736	Artificial Neural Network
26.	EE738	Advanced Power Electronics

BOS Chairman   **Principal**

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING III SEMSTER		
Course Title : ANALOG ELECTRONIC CIRCUITS		
Course Code : EE31	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To study the basic concepts of diode circuits such as clippers, clampers and rectifiers
2. To analyze and design of different transistor circuit biasing along with bias stabilization.
3. To study the modeling of transistor& to analyze general, feedback and power amplifiers.
4. The basics concept of oscillators and FET amplifiers along with characteristics

Unit No.	Syllabus Content	No. of Hours
1	**Diode Circuits***:* Diode resistance, diode equivalent circuits, transition and diffusion capacitance, load line analysis, rectifiers, clippers and clampers.	10
2	**Transistor Biasing***:* Operating point, fixed bias circuits, emitter stabilized biased circuits, voltage divider bias, dc bias with voltage feedback, miscellaneous bias configurations. Design considerations. Transistor as a switch. PNP transistors circuits. Bias stabilization.	10
3	**A) Transistor Low Frequency Model***:* BJT modeling, hybrid equivalent model, approximate model. **B) Transistor Frequency Response***:* General frequency considerations, low frequency response, miller effect capacitance, high frequency response.	10
4	**A) General Amplifiers:** Cascade connections, cascode connections, Darlington connections. **B) Feedback Amplifiers:** Feedback concept, types of feedback, block diagram approach **C) Power Amplifiers**: Definitions and amplifier types, series fed class a amplifier, transformer coupled class A amplifiers & class B amplifiers.	11
5	**A) Oscillators:** Principle of operation, phase shift oscillator, tuned oscillator circuits, crystal oscillator. (BJT versions) **B) FET Amplifiers***:* FET small signal model, biasing of FET, common drain common gate configurations, MOSFET, FET amplifier networks.	11

Course Outcome: At the end of the course students will be able to -

CO1. Recall the basic diode circuits and define various wave shaping circuits.
CO2. Explain the working of transistor biasing circuits and locate quiescent point.
CO3. Analyze the models of transistor & FET amplifier circuits.
CO4. Design and develop various transistor amplifier circuits.
CO5. Construct and solve the transistor oscillator circuits.

TEXT BOOKS:

1. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education. 9TH Edition.

REFERENCE BOOK/WEBSITE LINKS:

1. Jacob Millman & Christos C. Halkias, Integrated Electronics, ,Tata McGraw Hill, 1991 Edition
2. David A. Bell, Electronic Devices and Circuits, PHI, 4th Edition, 2004

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7. 3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-I**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*				*	*		*	*
CO2	*	*	*	*				*	*		*	*
CO3	*	*	*	*				*	*		*	*
CO4	*	*	*	*				*	*		*	*
CO5	*	*	*	*				*	*		*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING III SEMSTER		
Course Title : TRANSFORMERS AND INDUCTION MACHIES		
Course Code : EE34	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To understand the concepts of transformers, induction machines and their analysis.
2. To evaluate the performance of transformers and induction machines.
3. To analyze the concepts to operate transformers in different configurations and operate in parallel.
4. To understand starters, methods of speed control of induction motor and induction generator.
5. To analyze induction motor with high torque rotors construction.

Unit No.	Syllabus Content	No. of Hours
1	**Basic Concepts: Review of p**rinciple of operation, constructional details of shell type and core type single-phase and three-phase transformers, EMF equation, losses and commercial efficiency, condition for maximum efficiency (No question shall be set from the review portion). Concept of ideal transformer, operation of practical power transformer under no load and on load -with phasor diagrams. Equivalent circuit, Open circuit and Short circuit tests, calculation of parameters of equivalent circuit and predetermination of efficiency-commercial and all-day	10
2	**Transformer continuation: Voltage r**egulation and its significance. Objects of testing of transformers, polarity test, Sumpner’s test. **Three-phase Transformers:** Introduction, choice between single unit three-phase transformer and bank of single-phase transformers. Transformer connection for three phase operation – star/star, delta/delta, star/delta, delta /star and V/V**.** Phase conversion - Scott connection for three-phase to two-phase conversion. Labeling of three-phase transformer terminals. Current inrush in transformers.	08
3	**(a) Parallel operation (Single-phase & Three-phase)**: Need, conditions to be satisfied for parallel operation. Load sharing in case of similar and dissimilar transformers. **(b) Instrument Transformers:** Current transformer and Potential transformer. **(c) Three phase Induction Machines: Review of c**oncept of rotating magnetic field. Principle of operation, construction of squirrel-cage, slip-ring induction motor (No question shall be set from the review portion).	10
4	**(a)** Characteristic Induction Motor continuation: Slip, torque, torque-slip characteristic. Maximum torque. **p**hasor diagram of induction motor on no-load and on load. Equivalent circuit, losses, efficiency. No-load and blocked rotor tests. Circle diagram and performance evaluation of the motor. Cogging and crawling. **(b)Starters & Speed Control of Three-phase Induction Motors:** Need for starter. Direct on line (DOL) starters, Star-Delta and autotransformer starting. Rotor resistance starting. Soft (electronic) starters. Speed control - voltage, frequency, and rotor resistance.	12
5	**(a) High torque rotors -** Double Cage and deep bar rotor, Equivalent circuit and performance evaluation of double cage induction motor. Induction generator – externally excited and self-excited. Importance of induction generators. **(b) Single-phase Induction Motor:** Double revolving field theory and principle of operation. Types of single-phase induction motors: split-phase, capacitor start, shaded pole motors. Applications.	12

Course Outcome: At the end of the course students will be able to -
CO1: Explain the construction, operation of transformer and induction machines (1-phase and 3-phase).
CO2: Understand the different connections for the three phase operations, advantages and applications.
CO3: Evaluate the performance of transformers and induction machines.
CO4: Analyze induction motors with different rotors and as induction generator.
CO5: Understand the different starters and speed control techniques of three-phase induction motors.

TEXT BOOKS:

1. **Electric Machines,** I. J. Nagrath and D. P. Kothari, T.M.H, 4^{th} Edition, 2010.
2. **Electrical technology-AC & DC Machines Vol-2, B L Theraja, S Chand Publishers.**

REFERENCE BOOK/WEBSITE LINKS:

1. **Performance and Design of A.C. Machines,** M. G. Say, C.B.S Publishers, 3rd Edition, 2002.
2. **Theory of Alternating Current Machines,** Alexander Langsdorf, T.M.H, 2^{nd} edition, 2001.
3. **Electrical Machines and Transformers**, Kosow, Pearson, 2^{nd} edition, 2007.
4. **Electric Machines, Mulukuntla S.Sarma, MukeshK.Pathak, CengageLearing, Firstedition, 2009.**

INSTRUCTIONS TO PAPER SETTERS
1: Students have to answer five full questions of 20 marks each.
2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.
3: Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*		*								*
CO2	*	*		*								*
CO3	*	*	*		*						*	*
CO4	*	*		*	*						*	*
CO5	*	*		*	*						*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU – 560056 ELECTRICAL AND ELECTRONICS ENGINEERING III SEMSTER		
Course Title : ELECTRONIC CIRCUITS LAB		
Course Code : EEL35	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

1. To construct various diode circuits to shape the waveforms to given specifications.
2. Design & construct circuits to verify basic theorems.
3. Design resonant circuits to resonate at required frequencies.
4. Design and test various amplifier circuits.
5. Design and verify circuits to oscillate at specified frequency.

Unit No.	Syllabus Content
	Introduction: Use of bread board, CRO, power supplies, signal generators, DRBs, DIBs, DCBs; color codes, resistors, inductors, capacitors, rheostats, multimeters; transistors, diodes; device data sheets.
1	Design and testing of diode clipping single & double ended circuits for peak clipping.
2	Design and testing of diode clipping single& double ended circuits for peak detection.
3	Design and testing of diode clamping circuits.
4	Testing of half wave, full wave and bridge rectifier circuits with and without capacitor filter, determination of ripple factor, regulation and efficiency.
5	Verification of Thevinin's theorem and maximum power transfer theorem for DC circuits.
6	Characteristics of series and parallel resonant circuits.
7	Design of RC coupled single stage amplifier and determination of the gain-frequency response, input and output impedances.
8	Design of BJT Darlington emitter follower circuit and determination of the gain, input and output impedances.
9	Design and testing for the performance of BJT-RC Phase shift oscillator for $f_0 \leq 10$ kHz
10	Design and testing for the performance of BJT-RC Hartley and Colpitt's oscillator for $f_0 \geq 100$ kHz
11	Design and experiment on BJT -crystal oscillator for $f_0 > 1$ MHz
12	Design of RC coupled two stage amplifier and determination of the gain-frequency response, input and output impedances.*
13	Design and testing of class B push pull power amplifier.*
	*** - Experiments beyond the syllabus**

Course Outcome: At the end of the course students will be able to -

CO1. Explain the working of diode wave shaping circuits and to draw transfer characteristics.
CO2. Build these circuit to verify the network theorems.
CO3. Test the resonant circuits resonating at required frequency.
CO4. Design of amplifier circuit, draw frequency response and determine input and output impedances
CO5. Construct and test transistor circuits to oscillate at desired frequencies.

REFERENCES:

1. Robert L. Boylestad and Louis NashelskyElectronic Devices and Circuit Theory, PHI/Pearson Education. 9TH Edition.
2. Laboratory Manual

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*		*	*					*	*	*
CO2	*	*		*	*					*	*	*
CO3	*	*		*	*					*	*	*
CO4	*	*		*	*					*	*	*
CO5	*	*		*	*					*	*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : MICROCONTROLLER		
Course Code : EE41	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:

1.To understand the concept and Architecture of Microcontroller, logical Instruction & Assembly programming.

2. To learn branching Instructions & C- programming,

3. To learn timer operation, modes of operation, interrupts, serial programming, Interfacing of ADC, DAC, Motor, LCD & Keyboard.

Unit No.	Syllabus Content	No. of Hours
1	**The 8051 Architecture:** Introduction, 8051 microcontroller hardware, input/output pins, ports, circuits, external memory, counter and timers, serial data input/output, interrupts.	7
2	**Addressing Modes and Operations**: Introduction, addressing modes, external data transfer, code memory, read only data moves/indexed addressing mode, push and pop. Data exchanges, example programs; byte level logical operations, bit level logical operations, rotate and swap operations, example programs. arithmetic operations: Flags, incrementing and decrementing, addition ,subtraction, multiplication and division, decimal arithmetic, program examples	8
3	**Jump and Call Instructions:** The Jump and CALL program range, jumps, calls and subroutines, interrupts and returns, more details on interrupts, program example.8051 programming in c: data types and time delays in 8051 c, I/O programming, logic operations, data conversion programs, accessing code ROM space, data serialization.	7
4	**Timer / Counter Programming in 8051**: Programming 8051 Timers, Counter programming, programming timers 0 and 1 using C/assembly language.	8
5	**8051 Serial Communication**: Basics of serial communication, 8051 connections to RS-232, 8051 serial communication programming. **Interrupts Programming:** 8051 Interrupts, programming timer interrupts, programming external hardware interrupts, programming the serial communication interrupts, interrupt priority in the 8051/52. **8051 Interfacing Applications**: Interfacing 8051 to LCD, keyboard, parallel and serial ADC, DAC, stepper motor interfacing, DC motor interfacing and PWM.	9

Course Outcome: At the end of the course students will be able to

CO1: Explain the architecture & difference between Microprocessor & Microcontrollers.

CO2: Use the arithmetic and logical instructions.

CO3: Use the instructions for writing assembly language and C program.

CO4: Use timers in Assembly Language and C program.

CO5: Use interrupts for serial and external peripherals interface.

TEXT BOOKS:

1. The 8051 Microcontroller Architecture, Programming & Applications, Kenneth J Ayla 2e, Penram International, 1996, Thomson Learning 2005.
2. The 8051 Microcontroller and Embedded Systems-Using Assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D McKinlay PHI/Pearson 2006.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 2 and 3 and questions 6 and 7 are to be from unit 2 and unit 5 respectively. Students have to answer Q.2 or Q.3 and Q.6 or Q.7.

3. Questions 1, 4 and 5 are to be set from units 1,3 and 4 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*		*	*					*
CO2	*	*	*	*		*	*					*
CO3	*	*	*	*		*	*					*
CO4	*	*	*	*		*	*					*
CO5	*	*	*	*		*	*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : CONTROL SYSTEMS		
Course Code : EE42	No. of Credits:4; L:T:P - 3:2:0	No. of hours/week: 3+2
Exam Duration: 3hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39+26

Course Objective:

1. To make the students aware of the basics of control system, its classification, the basic theory of Transfer Function, Impulse response and mathematical modeling for the overall analysis of the control system. Obtain transfer function using Block Diagram and Signal Flow Graph.
2. To make them understand the time response of feedback control systems and steady state errors.
3. Stability analysis is thought using various methods like Routh Hurwitz criterion, Root Locus and Bode Plot.

Unit No.	Syllabus Content	No. of Hours
1	a) **Modeling of Systems:** Introduction to control system, Mathematical models of physical systems – Introduction, Differential equations of physical systems. Mechanical systems – Translational and rotational systems (Mechanical accelerometer, Levered systems excluded), Electrical Analogous systems. P, PI and PID controllers. b) **Servomotor:** transfer functions, applications. c) **Block diagrams and signal flow graphs**: Transfer functions, Block diagram algebra, Signal Flow graphs (State variable formulation excluded)	9+6
2	**Time Response of feedback control systems:** Standard test signals, Unit step response of first and second order systems, Time response specifications, Time response specifications of second order systems, steady state errors and error constants.	8+5
3	a) **Stability analysis:** Concepts of stability, Necessary conditions for stability, Routh- stability criterion, Relative stability analysis. b) **Root Locus Techniques:** Introduction, root locus concepts, Construction of root loci and stability studies.	8+5
4	a) **Frequency domain analysis:** Introduction, Correlation between time and frequency response, bode plots, all pass and minimum phase systems, Assessment of relative stability using Bode Plots. b) Lag and lead compensators.	8+5
5	**Stability in the frequency domain:** Mathematical preliminaries, Nyquist stability criterion (Inverse polar plots excluded), Assessment of relative stability using Nyquist criterion (systems with transportation lag excluded).	6+5

Course Outcome: At the end of the course students will be able to -
CO1: Demonstrate an understanding of the fundamentals of control systems.
CO2: Apply the concepts to develop mathematical modeling and transfer function of any system using various techniques.
CO3: Analyze the control system with respect to system stability in time and frequency domain.
CO4: Analysis of system stability using graphical methods.
CO5: Design system using compensator for better performance.

TEXT BOOKS:

1. Control Systems Engineering, J. Nagarath and M.Gopal, New Age International (P) Limited, Publishers, First edition – 2008

REFERENCE BOOK/WEBSITE LINKS:

1. Modern Control Engineering, K. Ogata, Pearson Education Asia/ PHI, 4th Edition, 2002.
2. Concepts of Control Systems, P. S. Satyanarayana; Dynaram publishers, Bangalore, 2001
3. Control Systems – Principles and Design, M. Gopal, TMH, 1999.
4. Feedback Control System Analysis And Synthesis, J. J. D'Azzo and C. H. Houpis; McGraw Hill

---

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 4 and 5 are to be from unit 1 and unit 3 respectively. Students have to answer Q.1 or Q.2 and Q.4 or Q.5.

3. Questions 3, 6 and 7 are to be set from units 2, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*										*
CO2	*	*	*			*				*		*
CO3	*	*	*			*				*		*
CO4	*	*	*			*				*		*
CO5	*	*	*			*				*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : GENERATION, TRANSMISSION AND DISTRIBUTION		
Course Code : EE45	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. To study various power generation techniques.
2. To study overhead and underground transmission systems.
3. To study the concepts of insulators, corona and distribution systems.
4. To study the calculation of inductance and capacitance of single phase and three phase lines.
5. To analyze the performance of power transmission lines.

Unit No.	Syllabus Content	No. of Hours
1	**Generation:** Sources of electrical power: General arrangement & working of nuclear, thermal and hydro power plant (block diagram approach only) , nuclear power plant - site selection, pros and cons, thermal power plant – site selection, pros and cons, hydro power plant – classification, site selection, pros and cons. **Introduction to typical transmission and distribution systems:** General layout of power system, Standard voltages for transmission, advantages and limitation of AC transmission system.	08
2	**Overhead Transmission Lines**: Types of supporting structures and line conducting materials used. Sag calculation- supports at same level and at different levels. Effect of wind and ice, Sag at erection, Stringing chart and sag templates. Line vibration dampers. **Underground Cables:** Types, material used, insulation resistance, charging current, grading of cables - capacitance grading & inter sheath grading, testing of cables.	10
3	**Insulators**: Introduction, materials used, classification, potential distribution over a string of suspension insulators. String efficiency & methods of increasing string efficiency - grading rings and arcing horns. Testing of insulators. **Distribution systems:** Requirements of power distribution, radial & ring main systems, AC and DC distribution - Calculation for concentrated loads and uniform loading, illustrative examples. **Corona:** Phenomena, disruptive and visual critical voltages, corona power loss, illustrative examples. Advantages and disadvantages of corona.	12
4	**Line parameters:** Calculation of inductance of single phase line, three phase line with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Capacitance of single phase line, three phase line with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines.	12
5	**Performance of Power Transmission Lines:** Short transmission lines, medium transmission lines- nominal T, end condenser and π models, long transmission lines, ABCD constants of transmission lines, Ferranti effect, line regulation.	10

Course Outcome: At the end of the course students will be able to -
CO1: Explain the construction and working of generating system, distribution system, insulators & underground cables.
CO2: Apply acquired knowledge & techniques to solve problems on transmission and distribution.
CO3: Analyze the performance of power transmission lines and distribution system.
CO4: Determine the necessary expressions for evaluating concepts of transmission and distribution
CO5: Discuss various concepts of overhead transmission lines.

TEXT BOOKS:
1.Electric Power Generation, Transmission and Distribution, S. M. Singh, PHI, 2nd Edition,2009
2. A Course in Electrical Power. Soni Gupta & Bhatnagar, Dhanpat Rai & Sons, 3rd edition, 2010.
3. Electrical Power Systems. C. L. Wadhwa, New Age International, 6th edition, 2010
REFERENCE BOOK/WEBSITE LINKS:
1. Elements of Power System Analysis. W.D. Stevenson, TMH, 4th Edition.
2. Electric power generation Transmission & Distribution. S. M. Singh, PHI, 2nd Edition, 2009.
3. Electrical Power. Dr. S. L. Uppal, Khanna Publications.

INSTRUCTIONS TO PAPER SETTERS
1: Students have to answer five full questions of 20 marks each.
2: Questions 2 and 3 and questions 6 and 7 are to be from unit 2 and unit 5 respectively. Students have to answer Q.2 or Q.3 and Q.6 or Q.7.
3. Questions 1, 4 and 5 are to be set from units 1, 3 and 4 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1		*										*
CO2	*		*	*		*						
CO3	*	*	*		*	*						
CO4	*	*	*		*	*						
CO5	*		*		*	*						

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : MICROCONTROLLER LAB		
Course Code : EEL46	No. of Credits:1.5; L:T:P - 0:0:1.5	No. of hours/week:3
Exam Duration: 3 hrs.	CIE + SEE = 50+ 50 = 100 Marks	

Course Objective:

1. To provide a practical introduction to microcontrollers assembly language & embedded C programming techniques, hardware interfacing circuit.

Unit No.	Syllabus Content	No. of Hours
	I. PROGRAMMING:	3
1	Data Transfer - Block move, Exchange, Sorting, Finding largest element in an array.	3
2	Arithmetic Instructions - Addition/subtraction, multiplication and division, square, Cube – (16 bits Arithmetic operations – bit addressable).	3
3	Counters.	3
4	Boolean & Logical Instructions (Bit manipulations).	3
5	Conditional CALL & RETURN.	3
6	Code conversion: BCD – ASCII; ASCII – Decimal; Decimal - ASCII; HEX - Decimal and Decimal - HEX.	3
7	Programs to generate delay, Programs using serial port and on-Chip timer / counter.	3
	II. INTERFACING 8051 CHIP USING C PROGRAMS	
8	Simple Calculator using 6 digit seven segment display and Hex Keyboard.	3
9	Alphanumeric LCD panel and Hex keypad input.	3
10	External ADC and Temperature control.	3
11	Generation of different waveforms - Sine, Square, Triangular, Ramp etc. using DAC; changing the frequency and amplitude.	3
12	Stepper and DC motor control.	3
13	Elevators.	

Course Outcome: At the end of the course students will be able to -

CO1: Understand different instruction set and architecture of 8051 Microcontroller.
CO2: Write & Analyze assembly language programming.
CO3: Understand usage of directives, Code Memory & external memory.
CO4: Write assembly language program using bit instructions.
CO5: Build Interfacing Circuit using embedded C programming.

TEXTBOOK:

1. The 8051 Microcontroller Architecture, Programming & Applications, Kenneth J Ayla 2e, Penram International, 1996, Thomson Learning 2005.
2. The 8051 Microcontroller and Embedded Systems-Using Assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D McKinlay PHI/Pearson 2006.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*		*	*					*
CO2	*	*	*	*		*	*					*
CO3	*	*	*	*		*	*					*
CO4	*	*	*	*		*	*					*
CO5	*	*	*	*		*	*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING IV SEMSTER		
Course Title : TRANSFORMERS AND INDUCTION MACHINES		
Course Code : EEL47	No. of Credits:1.5; L:T:P - 0:0:1.5	No. of hours/week:3
Exam Duration: 3 hrs.	CIE + SEE = 50+ 50 = 100 Marks	

Course Objective:

1. To introduce various tests on Transformer, poly-phase Induction Machines and single-phase Induction Motor and evaluation of their performance.
2. To verify the parallel operation of two dissimilar transformers load sharing.
3. To learn various methods of speed control of Induction motor.
4. To study the connection of single phase transformers for three phase operation and phase conversion.

Unit No.	Syllabus Content	No. of Hours
1	(a) Predetermination of efficiency and regulation by Open Circuit and Short circuit tests on single - phase transformer. (b) Calculation of equivalent circuit parameters from the test data and determination of efficiency, Regulation from the equivalent circuit to correlate results obtained earlier.	3
2	Sumpner's test on similar transformers and determination of combined and individual transformer efficiency	3
3	Parallel operation of two dissimilar (different kVA) single-phase transformers and determination of load sharing and analytical verification given the Open Circuit and Short circuit tests details.	3
4	Polarity test and connection of 3 single-phase transformers in star – delta and determination of efficiency under balanced and unbalanced resistive load.	3
5	Scott connection with balanced and unbalanced resistive loads.	3
6	Load test on 3-phase induction motor and determination of performance characteristics.	3
7	(a) NO load and Blocked rotor tests on 3-phase induction Motor Predetermination of performance from the Circle diagram. (b) Determination of parameters of the equivalent circuit of a 3-phase Induction Motor and correlate the results obtained from the circle diagram.	3
8	Speed control of 3-phase induction motor by varying rotor resistance.	3
9	Load test on- induction generator.	
10	Load test on single- phase induction motor.	3

Course Outcome: At the end of the course students will be able to -

CO1: Conduct various tests on single-phase transformer, and evaluate their performance

CO2: Poly-phase induction machines and single-phase induction motor and evaluate their performance

CO3: Operate two dissimilar transformers in parallel for different load sharing.

CO4: Experiment the various methods of speed control of Induction motor.

CO5: Examine the connection of single phase transformers for three phase operation and phase conversion.

REFERENCE: Laboratory manual

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*				*			*	*	*	*	
CO2	*				*			*	*	*	*	
CO3	*			*	*				*	*	*	
CO4	*			*	*				*	*	*	
CO5	*				*							

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : SIGNALS AND SYSTEMS		
Course Code : EE51	No. of Credits:3; L:T:P - 2:2:0	No. of hours/week: 2 + 2
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 26+26

Course Objective:

1. To learn the different types of signals and properties of Signals & Systems, convolution for LTI systems.
2. To visualize the relationship between the continuous-time, discrete-time Fourier series and Fourier transform of a signal.
3. To learn the applications of Fourier Transform.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction:** Definition of a signal and system, overview of systems, classifications of signals, basic operation on signals, elementary signals and systems viewed as interconnection of operations, properties of systems.	07
2	**Time Domain Representation For LTI Systems (Continuous & Discrete)**: Convolution, impulse response representation, properties of impulse response representation, solution of differential & difference equations, block diagram representation.	09
3	**Frequency Domain Representation of Signals and its Applications**: Introduction, Fourier representation of continuous-time periodic signals, properties of CTFS (excluding derivation of defining equations for CTFS), Fourier representation of discrete-time periodic signals, properties of DTFS (excluding problems on DTFS)	7
4	**Continuous-Time Fourier Transform:** Representation of non periodic signals, properties of continuous time Fourier transforms. **Application of Fourier Representation:** Frequency response of lti systems. Solution of difference equations using system function, sampling of continuous time signals & signal reconstruction.	09
5	**Discrete-Time Fourier Transform:** Properties of continuous time Fourier transform. **Applications:** Frequency response of LTI systems, solution of difference equations using system function.	7

Course Outcome: At the end of the course students will be able to -

CO1: Characterize and analyze the properties of CT and DT signals and systems
CO2: Analyze LTI CT and DT systems in time domain using convolution.
CO3: Analyze systems for discrete-time (DT) and continuous-time (CT) signals;
CO4: Represent CT and DT systems in the Frequency domain using Fourier analysis tools.
CO5: Analyze Fourier transform for differential & difference equation applications.

TEXT BOOKS:

1. Simon Haykin and Barry VamVeen, "Signals & Systems", John Wiley & Sons, 2001. Reprint 2002.
2. Alan V Oppenheim, Alan Willsky and S. Hamid Nawab "Signals & Systems" Pearson Education Asia, 2nd edition 1997. Indian Reprint 2002.
3. Michael J Roberts, "Signals & Systems Analysis of signals through linear systems" Tata McGraw Hill, 2003.

REFERENCE BOOK/WEBSITE LINKS:

1. P Ramakrishna Rao and Shankar Prakriya, "Signals & Systems", McGraw Hill, 2nd edition.
2. J B Gurung, "Signals & Systems", PHI, 2015.
3. Dr. D Ganesh Rao and SatishTunga, "Signals& Systems", Sanguine Technical Publishers, 5th edition.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.
2: Questions 2 and 3 and questions 5 and 6 are to be from unit 2 and unit 4 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.
3. Questions 1, 4 and 7 are to be set from units 1, 3 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*						*		*		*
CO2	*	*						*		*		*
CO3	*	*						*		*		*
CO4	*	*						*		*		*
CO5	*	*						*		*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : POWER ELECTRONICS -II		
Course Code : EE52	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. Understand the speed control and braking methods of electrical drives for day to day applications.
2. Analyze the performance of converter fed DC and Induction motors along with speed torque characteristics.
3. Explain various speed - torque control techniques for industrial applications.
4. Design the modeling of drives in open loop and closed loop condition to justify their applications.

Unit No.	Syllabus Content	No. of Hours
1	**Control Of DC Drives: DC** Machine Operation In Motoring, Generating And Braking Modes. **Schemes Of DC Motor Speed Control:** Single Phase Separately Excited Drive; Series And Shunt Motor; Three phase Full Converter in continuous and discontinuous mode of operation, Illustrative Problems	**12**
2	**Closed Loop Control Of DC Drives:** open loop and closed loop transfer function of separately excited motor and series motor; - current, voltage and speed control of separately excited drive & series drive	**10**
3	**Control Of AC Drives :**Basic Induction Motor Equations **Schemes Of Induction Motor Speed Control:** control of squirrel cage induction motor by voltage source and current source inverter; illustrative problems.	**12**
4	**Speed Control Of Induction Motor :** stator voltage control; variable frequency control; rotor resistance control; slip power recovery scheme; closed loop speed control.	**10**
5	**Digital Control Of Electric Drives :** PLL Control of DC drive; microcontroller control of dc and AC drive; applications, merits and demerits of AC & DC drives.	**8**

Course Outcome: At the end of the course students will be able to -

CO1:State the speed control and braking methods of electric drives for day today applications

CO2: Understand voltage and torque equations to differentiate the behaviour of electric drives for industrial applications.

CO3: Apply various power converters and control techniques to control speed and torque of DC and ACmotors.

CO4: Analyze the characteristics of different motors to model and their applications in real world

CO5: Develop digital methods for speed and torque control of electric drives.

TEXT BOOKS:

1. **G K Dubey,Fundamentals of electric drives , Narosa Publications,1995**
2. M.D. Singh and Khanchandani K.B **Power Electronics**, Tata.Mc.Hill. 2012.
3. M.H.Rashid, **Power Electronics,** P.H.I. /Pearson, New Delhi, 2002, 2nd Edition.

REFERENCE BOOK/WEBSITE LINKS:

1. Ned Mohan, Tore M. Undeland, and William P. Robins, **Power Electronics - Converters, Applications and Design,** John Wiley and Sons, .Third Edition,
2. G.K. Dubey, **Power Semi-conductor drives.**
3. R Krishnan, **Electric motor drives – Modelling, Analysis and Control**, Pearson.
4. **Shepherd Hulley, Power Electronics and Motor control ,Cambridge University Press,2nd Edition,**
5. **P C Krause, Analysis of Electric machinery and drive systems, IEEE presses, 2ndEdition**https://onlinecourses.nptel.ac.in

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 4 and 5 are to be from unit 1 and unit 3 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.

3. Questions 3, 6 and 7 are to be set from units 2, 4 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*	*	*								
CO2	*		*	*							*	
CO3			*	*	*							
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : DC Machines and Synchronous Machines		
Course Code : EE53	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To gain knowledge on construction and working of DC machines and synchronous machines.
2. To study characteristics of DC machines and synchronous machines
3. To study various methods of testing, losses and efficiency of DC machines.
4. To analyze various methods of determining voltage regulation of a synchronous generator.
5. To analyze the operation of a synchronous machine (both as a generator and motor).

Unit No.	Syllabus Content	No. of Hours
1	**DC generator**: Review of basics of DC machines, classification of DC generator, types of armature winding, emf equation, no-load characteristic, armature reaction, load characteristics. Commutation, types of commutation, commutation difficulties, interpoles, compensating winding and equalizer rings (only qualitative treatment). Classification of DC motors, back emf and its significance, torque equation, characteristics of shunt, series & compound motors, speed control of shunt and series motors. Application of DC motors.	10
2	**Losses and efficiency:** losses in dc machines, power flow diagram, efficiency, condition for maximum efficiency. **Testing of dc machines**: direct & indirect methods of testing of dc machines-brake test, swine burn’s test, Hopkinson’s test, retardation test, field’s test, merits and demerits of tests.	10
3	**Synchronous machines:** Basic principle of operation, construction of salient & non-salient pole synchronous machines, generated EMF, effect of distribution and chording of winding, harmonics-causes, reduction and elimination. Armature reaction, synchronous reactance, leakage reactance, phasor diagram of non-salient type alternator.	10
4	**Voltage Regulation**: Voltage regulation by EMF, MMF, ZPF & ASA method. Short circuit ratio and its importance. Two reaction theory-direct and quadrature axis reactances, phasor diagram. Slip test and regulation. Synchronizing to infinite bus bars, parallel operation of alternators. Operating characteristics, power angle characteristics excluding armature resistance, operation for fixed input and variable excitation.	12
5	**Synchronous motor:** Principle of operation, phasor diagrams, torque and torque angle, Blondel diagram, effect of change in load, effect of change in excitation, ‘V’ and ‘inverted V curves’. Synchronous condenser, hunting and damping. Methods of starting of synchronous motors. **Special DC motors**: Permanent magnet motors, brushless DC motors. Applications.	10

Course Outcome: At the end of the course students will be able to -
CO1. Explain constructional features and phenomena related to DC, synchronous machines and special machines. (L1)
CO2. Explain the operation, characteristics and performance to DC, synchronous machines and special machines. (L2)
CO3. Solve problems related to speed control, losses and efficiency of DC machines.(L3)
CO4. Analyze the behavior of synchronous machines in parallel and on infinite busbars.(L4)
CO5. Evaluate voltage regulation of synchronous generators by various methods. (L5)

TEXT BOOKS:

1. Electrical Machinery:DP Kothari, I.J.Nagarath, TMH, 4th edition, 2010.
2.Electrical Machines:P.S Bhimbra, Khanna Publishers
3. Electric Machines: Mulukuntla.S.Sarma, Mukesh.K.Pathak, Cengage Learning, First edition, 2009.
4. Electric Machines: AhhijitChakrabarti, SudiptaBebnath, McGraw Hill Education (India) Private Limited, New Delhi.

REFERENCE BOOK/WEBSITE LINKS:

1. Performance& Design of Alternating Current machines**:** M. G. Say, CBS publishers, 3rd Edition, 2002.
2. The Performance & Design of DC machines:A.E Clayton &N.N.Hancock CBS Publication, 3rd Edition, 2004.

3. Electrical Machines: AshfaqHussain, DhanpatRai Publications.

INSTRUCTIONS TO PAPER SETTERS
1: Students have to answer five full questions of 20 marks each.
2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.
3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*		*					*
CO2	*	*	*	*	*		*					*
CO3	*	*	*	*	*		*					*
CO4	*	*	*	*	*		*					*
CO5	*	*	*	*	*		*					*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : CONTROL SYSTEMS LAB		
Course Code : EEL56	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

1. To study Transient and steady state behavior of linear control systems, study frequency and Time domain response characteristics of 2nd order systems.
2. To design compensating networks for improvement of stability, study AC/DC servomotor performance.

Unit No.	Syllabus Content
1	Simulation of a typical second order system and determination of step response and evaluation of time- domain specifications using a software tool
2	(a) Design of a passive RC lead compensating network for the given specifications, viz., the maximum phase lead and the frequency at which it occurs and to obtain its frequency response. (b) Experimental determination of transfer functions of a lead compensating network.
3	(a) Design of a RC lag compensating network for the given specifications. viz., the maximum phase lag and the frequency at which it occurs, and to obtain its frequency response. (b) Experimental determination of transfer functions of a lag compensating network.
4	Study of the effect of P, PI, PD and PID controller on the step response of a feedback control system (using control engineering trainer/process control simulator).
5	Speed – torque characteristic of a two - phase A.C. servomotor.
6	Speed torque characteristic of a D.C. servomotor.
7	Experimental determination of frequency response of a second -order system and evaluation of frequency domain specifications
8	Simulation of a D. C. position control system and its step response.
9	Determination of phase margin and gain margin of a transfer function by Bode Plots and verification by simulation.
10	Construction of root locus of transfer function and verification by simulation.
11	Synchro pair characteristics.

Course Outcome: At the end of the course students will be able to -

CO1: Understand and analyze the time and frequency domain specifications for a second order system.

CO2:Analyze the performance of servomotors.

CO3: Evaluating system performance using P,I,D controllers

CO4: Design the control system with compensators.

CO5: Use MATLAB for simulation and validation of results obtained by analytical calculations.

REFERENCES:

1.Matlab user manual, Ogata

2.Matlab by Rudrapratap

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*	*	*			*	*		*
CO2	*	*	*	*	*	*			*	*		*
CO3	*	*	*	*	*	*			*	*		*
CO4	*	*	*	*	*	*			*	*		*
CO5	*	*	*	*	*	*			*	*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : POWER ELECTRONICS LAB		
Course Code : EEL57	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

1. To learn observe the characteristics of Power semiconductor devices practically.
2. To implement the controllable switches in different power electronic converter circuits for applications such as speed control of electrical machines and practical loads.

Unit No.	Syllabus Content
	Introduction to laboratory and data sheets of devices
1	Static characteristics of SCR.
2	Static characteristics of MOSFET and IGBT.
3	SCR turn-on circuit using UJT relaxation oscillator.
4	SCR Digital triggering circuit for single phase controlled rectifier.
5	Single-phase full-wave rectifier with *R* and *R-L* loads, with and without freewheeling diode
6	A.C. voltage controller using TRIAC – DIAC/UJT combination connected to *R* load
7	Speed control of a stepper motor.
8	Speed control of a universal motor / single-phase induction motor using A.C. voltage
9	Speed control of a separately excited D.C. motor using an IGBT/ MOSFET chopper.
10	MOSFET /IGBT based single-phase full-bridge inverter connected to R load.
11	Simulate the dynamic characteristics of (i) MOSFET (ii) IGBT (iii) BJT *
12	For given dv/dt ratings, design a snubber circuit and observe the response of the circuit by* simulation
13	Study the performance of SCR forced commutating circuits.— (i) By reducing the forward current below the holding current (current commutation) (ii) By applying a large reverse voltage across conducting SCR (Voltage commutation) *
	* - Experiments beyond syllabus

Course Outcome: The student will have,
CO1. An ability to understand basic operation of various power semiconductor devices and passive components.
CO2. An ability to understand the basic principle of switching circuits.
CO3. An ability to analyze and design an AC/DC rectifier circuit.
CO4. An ability to analyze and design DC/DC converter circuits.
CO5. An ability to analyze DC/AC inverter circuit.

REFERENCES:

1. Power Electronics, M.H.Rashid, 2nd Edition, P.H.I. /Pearson, New Delhi, 2002.

2. Power Electronics – Converters, Applications and Design, Ned Mohan, Tore M. Undeland, and William P. Robins,Third Edition, John Wiley and Sons.

3. Laboratory Manual

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*		*			*	*		*
CO2		*	*	*	*					*		
CO3	*		*		*	*			*			
CO4		*		*		*				*		
CO5	*	*	*	*	*	*			*	*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING V SEMSTER		
Course Title : LINEAR ICS AND APPLICATIONS		
Course Code : EE553	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. To acquaint the students with the basic characteristic and operation of op-amp and frequency response of op-amp.
2. To enable students to apply op-amp in AC amplifier circuits.
3. To design & analyze different linear, non-linear & mathematical application circuits using op-amp.
4. To learn some special applications of op-amps in integrated circuits.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction:** Operational amplifier description-–Circuit symbol and terminals, block diagram. Basic op-amp parameters- Input and output voltage range, offset voltage and current, offset nulling, CMRR, PSRR, input and output impedance, slew rate **(no question shall be set from the introduction)** **OP-Amps as AC Amplifiers:** Capacitor-Coupled voltage follower, High Z_{in} Capacitor Coupled voltage follower, Capacitor-Coupled non-inverting amplifier, High Z_{in} Capacitor Coupled non-inverting amplifier, Capacitor-Coupled inverting amplifier, setting upper cut off frequency, use of single polarity supply. **OP-Amp Frequency Response And Compensation:** Op-amp circuit stability, frequency and phase response, frequency compensating methods, manufacturer's recommended compensation, slew rate effects, stray capacitance effects, load capacitance effects, Z_{in} mode compensation, circuit stability precautions.	12
2	**Signal Processing Circuits:** Introduction, saturating precision half wave rectifier, non-saturating half wave precision rectifier, two output precision half wave rectifier, precision full wave rectifier using half wave rectifier and summing circuit, high input impedance full wave precision rectifier, peak clipper, dead zone circuit, precision clipper, precision clamping circuit, precision rectifier peak detector, voltage follower peak detector, sample and hold circuit.	10
3	**OP-Amp Nonlinear Circuits:** Op-amps in switching circuits, zero crossing detectors, Inverting & Non inverting Schmitt trigger circuits, Astable multivibrator and monostable multivibrator. **Signal Generators:** Triangular wave generator, rectangular wave generator, phase shift oscillator, Wien bridge oscillator.	10
4	**Active Filters:** First order low pass active filter, second order low pass active filter, first order high pass active filter, second order high pass active filter, band pass filter, band stop filter.	10
5	**DC Voltage Regulators:** Basic linear voltage regulator, fixed output voltage regulators , adjustable output regulator(LM317/LM337), IC voltage regulators(IC723) **Specialized IC Applications:** Basics of universal active filter, basic phase lock loops, power amplifiers.	10

Course Outcome: At the end of the course students will be able to -
CO1: Recall the basics of op-amp.
CO2: Understand the behavior of op-amp linear and non- linear circuits.
CO3: Understand the operation of op-amp in signal processing and oscillator circuits.
CO4: Analyze the application of op-amp in nonlinear circuits.
CO5: Design a circuit or system using integrated circuits.

TEXT BOOKS:

1. David A Bell, "Operational amplifiers and linear ICs", 3rd edition, Oxford University Press, 2010.
2. B.Somanathan Nair, "Linear Integrated Circuits - Analysis, Design and Applications", 1st Edition, Wiley India, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. S. Salivahanan, V S KanchanaBhaaskaran, "Linear Integrated Circuits", 2nd Edition, McGraw Hill, 2015.
2. Stanley William D, "Operational amplifiers with Linear Integrated Circuits", 4th edition, Pearson Education.
3. Ramakanth A Gayakwad, "Operational amplifiers and linear ICs", 4th edition, PHI, 2009.

INSTRUCTIONS TO PAPER SETTERS
1: Students have to answer five full questions of 20 marks each.
2: Questions 2 and 3 and questions 4 and 5 are to be from unit 2 and unit 3 respectively. Students have to answer Q.2 or Q.3 and Q.4 or Q.5.
3. Questions 1, 6 and 7 are to be set from units 1, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1		*			*						*	
CO2	*	*	*	*								
CO3	*	*	*	*								
CO4		*	*	*	*		*					
CO5	*	*	*	*	*						*	

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : POWER SYSTEMS ANALYSIS		
Course Code : EE61	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective: Students will learn to

1. Modeling of power system elements and representation the power system in single line diagrams.
2. Use symmetrical components in power system analysis.
3. Perform fault and stability analysis on power system network.
4. Evaluate the performance of induction machine under unbalanced supply conditions.

Unit No.	Syllabus Content	No. of Hours
1	**Representation of Power System Components:** Circuit models of transmission line, synchronous machines, transformers and load. Single line diagram, impedance and reactance diagrams. Per unit system, per unit impedance diagram of power system. **Symmetrical 3 - Phase Faults**: Transient, sub transient and steady state reactance's and currents of synchronous machines. Short-circuit currents of synchronous machines and power system.	11
2	**Symmetrical Components:** Introduction**,** three phase operator-**a**. Synthesis of unbalanced vector from its symmetrical components. Resolution of unbalanced phasors into their symmetrical components. Relation between Line & phase voltages in star connected system. Relation between Line & phase currents in delta connected system. Phase shift of symmetrical components in transformer banks. Power in terms of symmetrical component. Analysis of balanced and unbalanced loads against unbalanced 3 phases supply. Sequence networks of synchronous generators & transformers. Sequence networks of power system.	12
3	**Unsymmetrical Faults:** Single line to ground fault (LGF), line to line fault (LLF), double line to ground fault (LLGF): Determination of faults currents, terminal voltages, and connection of sequence networks. Fault on loaded synchronous generator. Fault with fault impedance. Unsymmetrical faults on power system.	10
4	**Concept of System Stability:** Introduction**,** classification ofstability, steady state and transient stability. Power angle equation of salient and non salient pole machines. Power angle curves. Stability limits and methods to improve stability. Rotor dynamics and the swing equation. Equal area criterion and critical clearing time. Apply equal area criterion for transient stability evaluation under different operating conditions of power system.	10
5	**Unbalanced Operation of Three Phase Induction Motors**: Open conductor faults in power system: sequence network connections. Analysis of three phase induction motor with one line open. Analysis of three phase induction motor with unbalanced supply.	09

Course Outcome: At the end of the course students will be able to -

CO1: Recall the equivalent circuits of power system components and to draw the single line & impedance diagrams of power system network.

CO2: Apply concept of symmetrical components to power system network.

CO3: Analyze the behavior of power system under different fault conditions.

CO4: Evaluate the steady state and transient stability of the Power Systems.

CO5: Investigate the effect of unbalanced operation and single phasing on the Performance of three phase induction machines.

`

TEXT BOOKS:

1. W.D.Stevenson, Elements of Power System Analysis, TMH,4th Edition
2. I.J.Nagrath and D.P.Kothari- Modern Power System Analysis. TMH, 3rd Edition, 2003.
3 Dr. P.N.Reddy, Symmetrical Components and Short Circuit Studies, Khanna Publishers.

REFERENCE BOOK/WEBSITE LINKS:

1. HadiSadat, Power System Analysis. TMH, 2nd Edition.
2. R.Bergen, and Vijay Vittal Power system Analysis, Pearson publications, 2nd edition, 2006.
3. G.L. Kusic, Computer Aided Power system analysis. PHI.Indian Edition, 2010
4. W.D. Stevenson & Grainger, Power System Analysis. TMH, First Edition, 2003.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 3 and 4 are to be from unit 1 and unit 3 respectively. Students have to answer Q.1 or Q.2 and Q.3 or Q.4.

3. Questions 5, 6 and 7 are to be set from units 3, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*						*			*
CO2	*	*	*	*								*
CO3	*	*	*						*			*
CO4	*	*	*			*					*	
CO5	*	*	*			*						*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : ELECTRICAL MACHINE DESIGN		
Course Code : EE62	No. of Credits: 4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To introduce the knowledge on basic principles of design, limitations and different materials used in electrical machines.
2. To understand the design concepts of static and rotating electrical machines.
3. To design and to interpret the design data of electrical machines.
4. To analyze design problems of machines/devices to satisfy the requirements.

Unit No.	Syllabus Content	No. of Hours
1	**Principles Of Electrical Machine Design:** Introduction, considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines. **Design Of Transformers (Single Phase and Three Phase):** Output equation for single phase and three phase transformers, choice of specific loadings, expression for volts/turn, determination of main dimensions of the core, types of windings and estimation of number of turns and conductor cross sectional area of primary and secondary windings.	12
2	**Estimation of Leakage Reactance and Tank Design of Transformers:** No load current, expression for leakage reactance and voltage regulation. Design of tank and cooling tubes (round and rectangular).	10
3	**Design of DC Machines:** Output equation, choice of specific loadings and choice of number of poles, design of main dimensions of the dc machines, design of armature slot dimensions, commutator and brushes, magnetic circuit - estimation of ampere turns, design of yoke and pole, field windings – shunt, series and inter pole.	10
4	**Design of induction Motors:** Output equation, choice of specific loadings, main dimensions of three phase induction motor, stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor, design of rotor bars and end ring, design of slip ring induction motor, estimation of no load current.	10
5	**Design of Synchronous Machines:** Output equation, choice of specific loadings, short circuit ratio, design of main dimensions, design of the field winding, armature slots and windings, slot details for the stator of salient and non-salient pole synchronous machines.	10

Course Outcome: At the end of the course students will be able to -
CO1: Define basic principles of design, merits and demerits.
CO2: Explain design concepts of power and distribution transformers.
CO3: Explain design concepts of AC and DC rotating electrical machines.
CO4: To solve the problems on design of power and distribution transformers.
CO5: To design the AC and DC rotating electrical machines.

TEXT BOOKS:

1. A.K. Sawhney, A Course in Electrical Machine Design. DhanpattRai& Sons
2. V. N. Mittle, Design of Electrical Machines., 4th edition.

REFERENCE BOOK/WEBSITE LINKS:

1. M.G. Say, Performance and design of AC Machines, CBS Publishers and Distributors Pvt. Ltd.
2. A. Shanmugasundarm, G. Gangadharan, R. Palani, Design Data Handbook. Wiley Eastern Ltd.

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 4 and 5 are to be from unit 1 and unit 3 respectively. Students have to answer Q.1 or Q.2 and Q.4 or Q.5.

3. Questions 3, 6 and 7 are to be set from units 2, 4 and 5 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1		*	*									
CO2	*		*						*			*
CO3		*										*
CO4			*						*			*
CO5			*						*			*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : DIGITAL SIGNAL PROCESSING		
Course Code : EE63	No. of Credits:4; L:T:P - 3:2:0	No. of hours/week: 03+02
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To understand DFT and its properties,
2. To learn FFT algorithm to find DFT.
3. To understand the structure of IIR & FIR system and to learn Digital IIR filter design using analog filter transformation.
4. To learn Digital FIR filter design

Unit No.	Syllabus Content	No. of Hours
1	**Discrete Fourier Transforms:** Definitions, properties-linearity, shift, symmetry etc., circular convolution – periodic convolution, use of tabular arrays, circular arrays, Stockholm's method, linear convolution – two finite duration sequence, one finite & one infinite duration, overlap add and save methods**.**	8+5
2	**Fast Fourier Transforms Algorithms:** Introduction, decimation in time algorithm, number of computations, number of multiplications, computational efficiency, decimation in frequency algorithms, inverse decimation in time and inverse decimation in frequency algorithms, decomposition for a composite number N=9.	8+5
3	**Realization of Digital Systems:** Introduction, block diagrams and SFGs, realization of IIR systems- direct form, cascaded, parallel form, realization of FIR systems – direct form, cascade form, linear phase realization.	7+5
4	**Design of IIR Digital Filters:** Introduction, impulse invariant & bilinear transformations, all pole analog filters- Butterworth & Chebyshev, design of digital Butterworth & Chebyshev, frequency transformations.	8+5
5	**Design of FIR Digital Filters:** Introduction, windowing, rectangular, modified rectangular, Hamming, Hanning, Blackman window (excluding Kaiser window), frequency sampling techniques.	8+6

Course Outcome: At the end of the course students will be able to -
CO1. Analyze and find DFT of signals.
CO2. Analyze and find DFT using FFT algorithms.
CO3. Realize structures for FIR & IIR systems.
CO4. Design IIR filters for the given specifications.
CO5. Design FIR filters for the given specifications**.**

TEXT BOOKS:

1. Proakis,"Digital Signal Processing Principle, Algorithm & application", Pearson, 4th education, 2009.
2. Sanjeet. K. Mitra,"Digital Signal Processing". TMH, 3rd Edition, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. Johnny R. Johnson"Introduction to Digital Signal Processing"**,** PHI, 2009.
2. Openheim,"Discrete Time Signal Processing "Pearson 2nd Edition 2009.
3. S.Salivahanan, A.Vallaraj, C.Gnanapriya"Digital Signal Processing"**,** TMH, 2nd Edition,

2010.
4. IfeachorEmmaue “Digital Signal Processing” l- Pearson education, 2^{nd} Edition, 2006.
5. Ludeman, “Fundamentals of Digital Signal Processing”. John Wiley, 3^{rd} Edition, 2008

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.

3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*						*		*		*
CO2	*	*		*				*		*		*
CO3	*	*						*		*		*
CO4	*	*		*				*		*		*
CO5	*	*		*				*		*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : DC Machines & Synchronous Machines Lab.		
Course Code : EEL66	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:
1. To introduce various testing methods for DC and synchronous machines.
2. To learn various losses occurring in DC machines and to find efficiency of a DC machines.
3. To learn the characteristics, performance and speed control of DC machines.
4. To determine voltage regulation of synchronous machines by various methods.
5. To study the behavior of synchronous machine connected to infinite bus bars.

Unit No.	Syllabus Content
1	Open circuit characteristics of DC machine.
2	Load characteristics of a D.C. shunt and compound generator - i) short shunt-cumulative and differential (ii) Long shunt-cumulative and differential.
3	Load test on a DC motor - determination of speed-torque and HP-efficiency characteristics.
4	Swinburne's test.
5	Hopkinson's test.
6	Speed control of DC motor by armature voltage control and flux control.
7	Ward Leonard method of speed control of D.C. motor.
8	Voltage regulation of an alternator by EMF and MMF method.
9	Voltage regulation of an alternator by ZPF method.
10	Slip test and determination of regulation.
11	Performance of synchronous generator connected to infinite bus under constant power and variable excitation.
12	V and Inverted V curves of a synchronous motor.
13	Field's test on series motors.*
14	Load test on series generator.*
	* - Experiments beyond syllabus

Course Outcome: At the end of the course students will be able to -
CO1: choose proper testing method to determine losses and efficiency of a DC machine and to determine voltage regulation of synchronous generator.
CO2: explain the characteristics of DC machines and synchronous machines by conducting suitable tests.
CO3: apply the basic concept for experimental determination of voltage regulation of synchronous generator.
CO4: analyze the performance of DC machines on load and synchronous machines on infinite bus bars.
CO5: evaluate the losses and efficiency of DC machines and performance of synchronous machines connected to infinite bus bars.

REFERENCES:
1. Laboratory Manual

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*							*	*		*
CO2	*	*							*	*		*
CO3	*	*							*	*		*
CO4	*	*							*	*		*
CO5	*	*							*	*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : DIGITAL SIGNAL PROCESSING LAB		
Course Code : EEL67	No. of Credits:1.5; L:T:P -0:0:1.5	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + SEE =50 + 50 = 100 Marks	

Course Objective:

Unit No.	Syllabus Content
1	Direct Computation of N-point DFT.
2	IIR filter realization using cascade form and Parallel form.
3	IIR Filter Design using Butterworth method.
4	IIR Filter Design using Chebyshev type 1 prototype.
5	IIR Filter Design using rectangular, hamming, window.
6	FIR Filter Design using Hanning, Blackman window.
7	N-Point Circular Convolution and Proof in frequency domain.
8	Circular Convolution, Linear Convolution and Linear Convolution using Circular Convolution.
9	Sampling Theorem.
10	Impulse response from X[n] and y[n].
11	Impulse response from difference equation and response to x[n].
12	N-point DFT using decimation in Time and Frequency FFT.*
13	N-point IDFT using decimation in Time and Frequency FFT.*
	* - Experiments beyond syllabus

Course Outcome At the end of the course students will be able to -
CO1: Write & execute the program to find DFT, Circular Convolution & Linear convolution.
CO2: Write & execute program to find Impulse response of LTI system.
CO3: Differentiate & Write program for FIR & IIR Filter Structures.
CO4: Design & Write program for IIR filters.
CO5: Design & Write program for FIR filters.

REFERENCES:

1. Proakis, Digital Signal Processing Principle, Algorithm & application. Pearson, 4th edition, 2009.
2. Sanjeet. K. Mitra, Digital Signal Processing. TMH, 3rd edition, 2009.
3. Laboratory Manual

COs	Mapping with POs										
	PO-a	PO-b	PO-c	PO-d	PO-e	PO-f	PO-g	PO-h	PO-i	PO-j	PO-k	PO-l
CO1	*	*			*			*		*		*
CO2	*	*		*	*			*		*		*
CO3	*	*			*			*		*		*
CO4	*	*		*	*			*		*		*
CO5	*	*		*	*			*		*		*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : PROGRAMMABLE LOGIC CONTROLLERS		
Course Code : EE643	No. of Credits:4; L:T:P - 3:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. The need of automation in the industry with basic controller mechanisms involved.
2. The programming concepts to achieve the desired goal or to define the various steps involved in the automation and the programming languages involved with basic subroutine functions.
3. To make use of the internal hardware circuits of automation circuit to control the devices during various states with monitoring the timers and counters.
4. To handle the data of the I/O devices to interface the data with the controller and auxiliary devices.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction:** Introduction to programmable logic controller (plc), role in automation (scada), advantages and disadvantages, hardware, internal architecture, sourcing and sinking, characteristics of I/O devices, list of input and output devices, examples of applications. I/O processing, input/output units, signal conditioning, remote connections, networks, processing inputs i/o addresses.	11
2	**Programming:** Ladder programming- ladder diagrams, logic functions, latching, multiple outputs, entering programs, functional blocks, program examples like location of stop and emergency switches.	10
3	**Programming Languages:** Instruction list, sequential functions charts & structured text, jump and call subroutines**.**	10
4	**Internal Relays:** Ladder programs, battery- backed relays, and one - shot operation, set and reset, master control relay. **Timers and Counters**: Types of timers, programming timers, on and off-delay timers, pulse timers, forms of counter, programming, up and down counters, timers with counters, sequencer.	11
5	**Shift Register And Data Handling**: Shift registers, ladder programs, registers and bits, data handling, arithmetic functions, temperature control and bottle packing applications.	10

Course Outcome: At the end of the course students will be able to -

CO1: Need of automation and its various control strategies with its auxiliary devices.

CO2:Programs for various functional block consisting of multiple inputs and outputs and to control

CO3:Programming issues with subroutines and debugged

CO4: The use of auxiliary units of a controller with hardware exposure.

CO5: The data handling with simple hardware.

TEXT BOOKS:

1. Programmable Logic controllers**.** W Bolton, 5th edition, Elsevier- newness, 2009.
2. 2**.** Programmable logic controllers **-** principles and applications. John W Webb, Ronald A Reis, Pearson Education, 5th edition, 2nd impression, 2007.

REFERENCE BOOK/WEBSITE LINKS:

1. Programmable Controller Theory and Applications, L.A.Bryan, E. A Bryan, An industrial text company publication, 2nd edition, 1997.
2. Programmable Controllers, An Engineers Guide. E. A Paar, newness, 3rd edition, 2003.https://onlinecourses.nptel.ac.in

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 5 and 6 are to be from unit 1 and unit 4 respectively. Students have to answer Q.1 or Q.2 and Q.5 or Q.6.

3. Questions 3, 4 and 7 are to be set from units 2, 3 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*								
CO2	*		*	*							*	
CO3			*	*	*							
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VI SEMSTER		
Course Title : SPECIAL MACHINES		
Course Code : EE652	No. of Credits:3; L:T:P - 3:0:0	No. of hours/week: 3
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 39

Course Objective:
1. Understand the concepts of Special electrical machines.
2. Analyze the necessity of sensors used in Special electrical machines.
3. Explain the characteristics and different speed - torque control schemes.
4. Model the electrical machines with voltage, current, torque and speed equations.

Unit No.	Syllabus Content	No. of Hours
1	**Stepper Motor:** Types of motors, working, windings, torque, characteristic, open and closed loop control, and microprocessor/microcontroller based control of motors, comparison of stepper motors, applications.	08
2	**Switched Reluctance Motor (SRM):** Construction, working, basics of SRM, pole arc and tooth arc, torque equation, characteristics, power converter circuits, current regulators, sensors, microprocessor/microcontroller based control of SRmotor and applications.	08
3	**Brushless Permanent Magnet DC (BLDC) Motor:** Classification of BLDC motors, construction, working, commutation, principle of operation, square wave generator, types of motors, and microprocessor/microcontroller/DSP based control of motors, Necessity of Hall sensors and optical sensors, comparison of brushed and brushless dc motors, applications.	10
4	**Permanent Magnet Synchronous Motor (PMSM):** Construction, principle of operation, emf equation, torque equation, comparison of conventional and PMSM motors, control and applications.	06
5	**Linear Induction Motor and Axial Flux Machines**: Construction, types, Principle of operation, and applications.	07

Course Outcome: At the end of the course students will be able to -
CO1: Understand the construction and operation of different special electrical machines.
CO2: Compare merits, demerits of different special electrical machines and their applications.
CO3: Explain the control and performance parameters of special electrical machines.
CO4: Develop torque equation and analyze speed –torque characteristics of special electrical machines.
CO5: Analyze different power converter topologies for operation of special electrical machines.
CO6: Apply digital control techniques for the operation and control of special electrical machines.

TEXT BOOKS:

1. E.G. Janardhanan,Special Electrical Machines, PHI, 2014.
2. K. Venkataratnam, Special Electrical Machines, University Press, Reprint, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. Miller, T.J.E.“Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, Oxford, 1989.
2. Kenjo, T, “Stepping Motors and their Microprocessor control”, Clarendon Press, Oxford, 1989.
3. Naser A and Boldea I, “Linear Electric Motors: Theory, Design and Practical Application”, Prentice Hall Inc., New Jersey,1987
4. R.Krishnan, Switched Reluctance motor drives-Modeling, Simulation, Analysis, Design, and Applications, CRC Press, 2015.

https://onlinecourses.nptel.ac.in/

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 3 and 4 and questions 6 and 7 are to be from unit 3 and unit 5 respectively. Students have to answer Q.3 or Q.4 and Q.6 or Q.7.

3. Questions 1, 2 and 5 are to be set from units 1, 2 and 4 respectively and are compulsory questions.

COs	Mapping with POs											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1		*										
CO2			*									
CO3			*									
CO4				*			*					
CO5					*		*					*
CO6									*	*	*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : HIGH VOLTAGE ENGINEERING		
Course Code : EE72	No. of Credits: 4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective: To impart the students

1. The basics of High voltage Engg and to learn Break down mechanisms of insulating media
2. The concepts on generation of High AC. DC and impulse voltages and currents.
3. To learn technique of measurement of High AC, DC and impulse voltages and currents.
4. To understand the testing of high voltage equipments.

Unit No.	Syllabus Content	No. of Hours
1	**Introduction:** Introduction to HV technology, role of insulation in electrical apparatus, need for generating high voltages in laboratory. Industrial applications of high voltage. **Breakdown phenomena:** Classification of HV insulating media. Properties of important HV insulating media under each category. **Gaseous dielectrics**: Ionization: primary and secondary ionization processes. Criteria for gaseous insulation breakdown based on Townsend’s theory. Limitations of Townsend’s theory. Streamer’s theory of breakdown in non-uniform fields. Corona discharges. Breakdown in electro negative gases. Paschen’s law and its significance. Time lags of breakdown. **Solid dielectrics**: Breakdown in solid dielectrics: intrinsic breakdown, avalanche breakdown, thermal breakdown, and electro mechanical breakdown. **Liquid dielectrics**: Breakdown of liquid dielectrics: Suspended particle Theory, Cavity breakdown (Bubble’s theory), and Stressed Oil Volume theory.	12
	Generation of HVAC voltages: HVAC-HV transformer; need for cascade connection and working of transformers units connected in cascade. Series resonant circuit- principle of operation and advantages. Tesla coil. **Generation of HVDC voltages:** Half and full wave rectifier circuits**,** voltage doubler circuit, Cockroft-walton type high voltage generator set. Calculation of voltage regulation, ripple and optimum number of stages for minimum voltage drop. Electrostatic generators - Van–de-graff generator.	10
3	**Generation of impulse voltage and current:** Introduction to standard lightning and switching impulse voltages. Analysis of single stage impulse generator-expression for output impulse voltage. Multistage impulse generator, working of modified Marx multi stage impulse generator circuit. Rating of impulse generator. Components of multistage impulse generator. Triggering of impulse generator by three electrode gap arrangement. Trigatron gap and oscillograph time sweep circuits. Generation of switching impulse voltage. Generation of high impulse current.	10
4	**Measurement of high voltages:** Electrostatic voltmeter-principle, construction and limitation. Chubb and fortescue method for HVAC measurement. Generating voltmeter- principle, construction. Series resistance micro ammeter for HVDC measurements. Standard sphere gap- measurement of HVAC, HVDC, and impulse voltages; factors affecting the measurements. Potential dividers-Resistance dividers, Capacitance dividers and mixed RC potential dividers. Measurement of high impulse currents- Magnetic links.	10

5	**Non-destructive insulation testing techniques:** dielectric loss and loss angle measurements using Schering bridge, transformer ratio arm bridge. Need for discharge detection and pd measurements aspects. Factor affecting the discharge detection. Discharge detection methods-straight and balanced methods. **High voltage tests on electrical apparatus**: Definitions of terminologies, tests on Isolators, Circuit Breakers, Cables, Insulators, Bushings and Transformers.	10

Course Outcome: At the end of the course students will be able to -
CO1: Explain the need for high voltages and currents\.
CO2: Explain the physics of break down mechanisms of insulating media.
CO3: Compare the merits and demerits of generation of high voltage and currents.
CO4: Select suitable method for measurement of high voltages and currents.
CO5: Explain the method of conducting the high voltage tests on different electrical equipments.

TEXT BOOKS:
1. M.S.Naidu and Kamaraju, High Voltage Engineering, - 4th Edition, TMH, 2008.
2. E.Kuffel and W.S. Zaengl, High Voltage Engineering Fundamentals, 2nd Edition, Elsevier Press,2005.

REFERENCE BOOK/WEBSITE LINKS:
1. R.S. Jha, High Voltage Engineering, DhanpatRai& Sons, New Delhi, 1984.
2. Mazen Abdel-Salam, Hussein Anis, Ahdab El- Morshedy, RoshdyRadwan, High Voltage Engineering Theory and Practice, 2nd Edition (Revised & Expanded) Marcel-Dekker Publishers (Special Indian edition.).

INSTRUCTIONS TO PAPER SETTERS
1: Students have to answer five full questions of 20 marks each.
2: Questions 1 and 2 and questions 3 and 4 are to be from unit 1 and unit 2 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.
3. Questions 5, 6 and 7 are to be set from units 3, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*											*
CO2	*						*					*
CO3		*					*					*
CO4		*		*								*
CO5			*									*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : EMBEDDED SYSTEMS		
Course Code : EE734	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. Understand embedded system and real time systems.
2. Real-time systems: Identify the unique characteristic, explain general structure and define the unique design problems and challenges of real-time system
3. Understand basics, program, design, implement and test an embedded system.

Unit No.	Syllabus Content	No. of Hours
1	**Concept of Embedded System Design:** Components, classification, skills required. Embedded Micro controller cores, Architecture of 6808 and 6811. Embedded Memories ROM variants and RAM. Applications of embedded system: Examples of Embedded systems SOC for cell less bar code scanner.	12
2	**Technological Aspects of Embedded System:** Interfacing between analog and digital blocks, Signal conditioning, digital signal processing, DAC & ADC interfacing, Sample & hold, multiplexer interface Internal ADC interfacing (excluding 6805 & 6812), Signal conditioning using DSP.	10
3	**Design Trade Offs Due to Process Incompatibility, Thermal Considerations:** Issues in embedded system design. Design challenge, design technology, tradeoffs. Thermal considerations.	10
4	**Software aspects of Embedded Systems**: Real time programming Languages, operating systems. Programming concepts and embedded programming in C. Round Robin, Round Robin with interrupts, function queue-scheduling architecture, Real time OS architecture, selecting architecture. Introduction to RTOS.	11
5	**Subsystem interfacing**: External system, user interfacing and Serial I/O devices, Parallel port interfaces: Input switches, Key boards and Memory interfacing. **Case Study:** Embedded velocity PID controller, PI controller with a PWM actuator.	09

Course Outcome: At the end of the course students will be able to -
CO1: To learn the concept of embedded microcontroller cores, architecture and application of embedded system.
CO2: To understand technological aspects of interfacing between analog and digital blocks.
CO3: Embedded system design issues in compatibility are to be understood.
CO4: To learn the method of designing a real time system.
CO5: To learn the technological hardware of embedded system aspects.

TEXT BOOKS:

1. Embedded Microcomputer systems: Real time interfacing.Valvano, J.W, Cengage Learning, 2nd Edition 5th Indian reprint,2009
2. The Art of Designing Embedded Systems. Ganssle, Jack, Newness
3. Embedded System, Architecture, Programming and Design. Raj Kamal, TMH, 2nd Edition 2008.

REFERENCE BOOK/WEBSITE LINKS:

1A Unified Hardware/Software Introduction. Frank Vahid/Tony Givargis, Wiley student edition 2002

2Motorola and Intel Manuals

3Embedded Software Premier. Simon David, Addison Wessly 2000

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 2 and 3 and questions 5 and 6 are to be from unit 2 and unit 4 respectively. Students have to answer Q.2 or Q.3 and Q.5 or Q.6.

3. Questions 1, 4 and 7 are to be set from units 1, 3 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*										
CO2			*	*	*							
CO3					*		*					
CO4									*	*		
CO5											*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : FUZZY LOGIC		
Course Code : EE735	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:
1. Provide an emphasis on the differences and similarities between fuzzy sets and classical sets theories and understanding of the basic mathematical elements of fuzzy sets.
2. Emphasis on fuzzy logic inference with premise on fuzzy proposition
3. provide an introduction to fuzzy linear and non –linear controller design
4. Provide an insight into structure and design of adaptive controller.
5. Apply fuzzy inference in the area of process control and real time applications.

Unit No.	Syllabus Content	No. of Hours
1	**THE MATHEMATICS OF FUZZY CONTROL:** Fuzzy sets, properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, the extension principle.	07
2	**THEORY OF APPROXIMATE REASONING:** Linguistic variables, Fuzzy proportions, Fuzzy if- then statements, inference rules, compositional rule of inference.	07
3	**NON-LINEAR FUZZY CONTROL:** FKBC as a linear transient element, PID like FKBC, sliding mode FKBC, Sugeno FKBC.	07
4	**FUZZY KNOWLEDGE BASED CONTROLLERS (FKBC):** Basic concept structure of FKBC, choice of membership functions, scaling factors, rules, fuzzyfication and defuzzyfication procedures. Simple applications of FKBC (washing machines, traffic regulations, lift control, aircraft landing Control etc.).	09
5	**ADAPTIVE FUZZY CONTROL:** Process performance monitoring, adaption mechanisms, membership functions, tuning using gradient descent and performance criteria. Set organizing controller model based controller.	09

Course Outcome: At the end of the course students will be able to -
CO1: Be able to distinguish between the crisp set and fuzzy set concepts.
CO2: Be able to define fuzzy sets using linguistic variables and represent these sets by membership functions.
CO3: Become knowledgeable of conditional fuzzy propositions and fuzzy inference systems
CO4: Become aware of the use of fuzzy inference systems in the design of controllers.
CO5: Become aware of the application of fuzzy inference in the area of process control.

TEXT BOOKS:
1. Fuzzy Logic With Engineering Applications-TimotyRoss, John Wiley, Second Edition, 2009.

2. Fuzzy Sets Uncertainty and Information- G. J. Klir and T. A. Folger, PHI IEEE, 2009.

REFERENCE BOOK/WEBSITE LINKS:

1. An Introduction to Fuzzy Control, D. Diankar, H. Hellendoom and M. Reinfrank,Narosa Publishers India, 1996.
2. Essentials of Fuzzy Modeling and Control, R. R. Yaser and D. P. Filer, John Wiley, 2007.
3. Fuzzy Logic Intelligence Control And Information, Yen- Pearson education, First Edition, 2006

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 6 and 7 are to be from unit 1 and unit 5 respectively. Students have to answer Q.1 or Q.2 and Q.6 or Q.7.

3. Questions 3, 4 and 5 are to be set from units 2, 3 and 4 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*									
CO2	*	*	*	*								
CO3			*	*								
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title : ARTIFICIAL NEURAL NETWORK		
Course Code : EE736	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. To organize the structural components.
2. Computation methodology needed for information extraction and storage.
3. Perform computation through learning algorithms.
4. Optimization techniques.

Unit No.	Syllabus Content	No. of Hours
1	Introduction, history, structure and function of single neuron, neural net architectures, neural learning, use of neural networks. Supervised learning, single layer networks, perceptrons, linear separability, perception training algorithm, guarantees of success, modifications.	10
2	Multiclass networks-I, multilevel discrimination, back propagation, setting parameter values, theoretical results. Accelerating learning process, application, and Madaline adaptive multilayer networks.	12
3	Prediction networks, radial basis functions, polynomial networks, regularization, unsupervised learning, winner-take-all networks. Learning vector quantizing, counter propagation networks, adaptive resonance theorem, topologically organized networks, distance based learning, recognition.	12
4	Associative models, Hop Field networks, brain state networks, Boltzmann machines, hetero associations.	09
5	Optimization using Hopfield networks, simulated annealing, random search, evolutionary computation.	09

Course Outcome: At the end of the course students will be able to -

CO1: Need of neural networks and its various realizations.

CO2: Analysis of neural networks various functional blocks with multiple inputs and outputs information.

CO3: Programming issues with application of neural networks to single input single output system.

CO4: Application of neural networks to multi input multi output system.

CO5: Salient features of input data mining and Realization of Hybrid systems.

TEXT BOOKS:

1. Elements Of Artificial Neural Networks -KishanMehrotra, C. K. Mohan, Sanjay Ranka, Penram, 1997
2. Artificial Neural Networks- R, Schalkoff, McGraw Hill, 1997.

REFERENCE BOOK/WEBSITE LINKS:

1. Neural Network Design- Hagan, Demuth and Beale Cengage,2nd Edition
2. Introduction To Artificial Neural Systems- J. Zurada, Jaico, 2003
3. Neural Networks -Haykins, PHI, 1999.
4. Artificial Neural Networks**,** B.Yegnanarayana, PHI, 2009 Edition

https://onlinecourses.nptel.ac.in

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 4 and 5 and questions 6 and 7 are to be from unit 4 and unit 5 respectively. Students have to answer Q.4 or Q.5 and Q.6 or Q.7.

3. Questions 1, 2 and 3 are to be set from units 1, 2 and 3 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*									
CO2	*	*	*	*								
CO3			*	*								
CO4	*	*							*		*	*
CO5				*	*		*				*	*

DR AMBEDKAR INSTITUTE OF TECHNOLOGY, BENGALURU - 560056 ELECTRICAL AND ELECTRONICS ENGINEERING VII SEMESTER		
Course Title: ADVANCED POWER ELECTRONICS		
Course Code : EE738	No. of Credits:4; L:T:P - 4:0:0	No. of hours/week: 4
Exam Duration: 3 hrs.	CIE + Assignment + SEE = 45 + 5 + 50 = 100 Marks	Total No. of Contact Hours: 52

Course Objective:

1. DC-DC circuit topologies analysis and operation.
2. Switching strategy and converter topologies for high frequency applications.
3. Design of high frequency magnetics.
4. Switching power supplies with electrical isolation for different power applications.

Unit No.	Syllabus Content	No. of Hours
1	**DC-DC SWITCHED MODE CONVERTERS:** Topologies, buck, boost, buck-boost, and cuk converters, full bridge DC-DC converter-detailed theory, working principles, modes of operation, with detailed circuits and wave forms, applications, merits and demerits	12
2	**DC-AC SWITCHED MODE INVERTERS:** Single-phase inverters, three phase inverters. SPWM inverter, detailed theory, working principles, modes of operation with circuit analysis, applications, merits and demerits, problems based on input output voltage relationship	11
3	**RESONANT CONVERTERS**: Zero voltage and zero current switching, resonant switch converters, and comparison with hard switching, switching locus diagrams, and working principle.	10
4	**HIGH FREQUENCY INDUCTOR AND TRANSFORMERS**: Design principles, definitions, comparison with conventional design and problems. Design of fly back transformer.	09
5	**POWER SUPPLIES**: Introduction, DC power supplies: fly back converter, forward converter, push-pull converter, half bridge converter, full bridge converter, AC power supplies: switched mode ac power supplies, resonant ac power supplies and bidirectional ac power supplies.	10

Course Outcome: At the end of the course students will be able to -

CO1: Name different power conversion topologies and it's with its auxiliary devices.

CO2: Discuss the various functional blocks with single inputs and multi outputs power supplies.

CO3: Evaluation of various control techniques

CO4: Analyze various components for high frequency applications.

CO5: Design power converters for various applications.

TEXT BOOKS:

1. **Power Electronics,** Daniel .W. Hart, TMH, First Edition, 2010.
2. **Power Electronics - converters, application & design**, Mohan N, Undeland T.M., Robins, W.P, John Wiley ,3rd Edition 2008
3. **Power Electronics-Circuits, Devices, Applications,** Rashid M.H., PHI, 3rd Edition, 2008.

REFERENCE BOOK/WEBSITE LINKS:

1. **Power Electronics Essentials and Applications**, L. Umanand, Wiley India Pvt Ltd,Reprint,2010
2. **Modern Power Electronics and A.C. Drives,** Bose B.K, PHI, 2009.
3. **Digital Power Electronics and Applications,** Muhammad Rashid, Elsevier, first edition, 2005.

4. **Power Electronics, Devices, Circuits and Industrial Applications** ,V.R.Moorthi,Oxford,7th impression,2009

https://onlinecourses.nptel.ac.in

INSTRUCTIONS TO PAPER SETTERS

1: Students have to answer five full questions of 20 marks each.

2: Questions 1 and 2 and questions 3 and 4 are to be from unit 1 and unit 2 respectively. Students have to answer Q.1 or Q.2 and Q.3 or Q.4.

3. Questions 5, 6 and 7 are to be set from units 3, 4 and 5 respectively and are compulsory questions.

COs	**Mapping with POs**											
	PO-a	**PO-b**	**PO-c**	**PO-d**	**PO-e**	**PO-f**	**PO-g**	**PO-h**	**PO-i**	**PO-j**	**PO-k**	**PO-l**
CO1	*	*	*	*								
CO2	*		*	*							*	
CO3			*	*	*					*		
CO4	*	*							*		*	*
CO5				*	*		*				*	*