Dr. Ambedkar Institute of Technology, Bengaluru-560056
Outcome Based Education(OBE) and Choice Based Credit System
Tentative Scheme of Teaching and Examination effective from the Academic Year 2024-25 (Batch 2022 -23)

VII SEMESTER (Swappable VII and VIII SEMESTER)

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self Study	Duration hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	IPCC	22EEU701	Modern Power System Protection	EEE	3	0	2		03	50	50	100	4
2	IPCC	22EEU702	Computer Methods in Power Systems	EEE	3	0	2		03	50	50	100	4
3	PCC	22EET703	Electrical Machine Design	EEE	3	2	0		03	50	50	100	4
4	PEC	22EET704x	Professional Elective Course	EEE	3	0	0		03	50	50	100	3
5	OEC	22EET705x	Open Elective Course		3	0	0		03	50	50	100	3
6	PROJ	22EEP706	Major Project Phase-II	EEE	0	0	12		03	100	100	200	6
										400	300	700	24

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course, **OEC**: Open Elective Course PR: Project Work, **L:** Lecture, **T**: Tutorial, **P**: Practical S= Self-Study, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD-** Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work

Professional Elective Course 22XXT704x			
22EET704A	Industrial Automation and Robotics	22EET704E	Industrial Drives and Application
22EET704B	Power System Operation and Control	22EET704F	Big data Analytics in Power System
22EET704C	FACTS and HVDC	22EET704G	AI for Power System Application
22EET704D	Energy Storage Systems		

Open Elective Course 22XXT705x	
22EET705A	Electric Vehicle Technology

Note: VII and VIII semesters of IV years of the program

(1) Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/ industry internships after the VI semester**.**

(2)Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether the VII or VIII semesters is completed during the beginning of the IV year or the later part of IV years of the program.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of Engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they canopt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under theguidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

PROJECT WORK (21XXP75): The objective of the Project work is

(i) To encourage independent learning and the innovative attitude of the students.

(ii) To develop interactive attitude, communication skills, organization, time management, and presentation skills.

(iii) To impart flexibility and adaptability.

(iv) To inspire team working.

(v) To expand intellectual capacity, credibility, judgment and intuition.

(vi) To adhere to punctuality, setting and meeting deadlines. To install responsibilities to oneself and others.

(vii) To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(2) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

Dr. Ambedkar Institute of Technology, Bengaluru-560056
Outcome Based Education(OBE) and Choice Based Credit System
Tentative Scheme of Teaching and Examination effective from the Academic Year 2024-25 (Batch 2022 - 23)

VIII SEMESTER (Swappable VII and VIII SEMESTER)

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self - Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PEC	22EET801x	Professional Elective (Online Courses)	EEE	3	0	0		-	-	-	-	3
2	OEC	22XXT802x	Open Elective (Online Courses)		3	0	0		-	-	-	-	3
3	INT	22EEI803	Internship (Industry/Research) (14 - 20 Weeks)		0	0	12		03	100	100	200	10
										200	200	400	16

L: Lecture, **T**: Tutorial, **P**: Practical S= Self-Study, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD-** Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work, **INT**: Industry Internship / Research Internship / Rural Internship.

Professional Elective Course (Online courses- NPTEL / VTU online Courses only) 22XXT801x

Open Elective Courses (Online Courses- NPTEL / VTU online Courses only) 22XXT802x

Note: VII and VIII semesters of IV years of the program Swapping Facility

- Institutions can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate **research internships/ industry internships/Rural Internship** after the VI semester**.**
- Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether VII or VIII semester is completed during the beginning of IV year or later part of IV year of the program.
- **Professional Elective and open elective Courses** to be selected with the approval of department elective committee constituted by the BOS chairman (HOD).

Elucidation:

At the beginning of IV years of the program i.e., after VI semester, VII semester classwork and VIII semester **Research Internship /Industrial Internship / Rural Internship** shall be permitted to be operated simultaneously by the University so that students have ample opportunity for an internship. In other words, a good percentage

of the class shall attend VII semester classwork and a similar percentage of others shall attend to Research Internship or Industrial Internship or Rural Internship.
Research/Industrial /Rural Internship shall be carried out at an Industry, NGO, MSME, Innovation center, Incubation center, Start-up, center of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations/institutes.
The mandatory Research internship /Industry internship / Rural Internship is for 14 to 20 Weeks. The internship shall be considered as a head of passing and shall be considered for the award of a Degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent University examination after satisfying the internship requirements.
Research internship: A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.
Industry internship: Is an extended period of work experience undertaken by students to supplement their Degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize,appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.
Rural Internship: Rural development internship is an initiative of Unnat Bharat Abhiyan Cell, RGIT in association with AICTE to involve students of all departments studying in different academic years for exploring various opportunities in techno-social fields, to connect and work with Rural India for their upliftment.
The faculty coordinator or mentor has to monitor the student's internship progress and interact with them to guide for the successful completion of the internship.The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of the internship.

- With the consent of the internal guide and Principal of the Institution, students shall be allowed to carry out the internship at their home town (**within or outside the state or abroad**), provided favorable facilities are available for the internship and the student remains regularly in contact with the internal guide.
  University/Institute shall not bear any cost involved in carrying out the internship by students. However, students can receive any financial assistance extended by the organization

Course Title	**MODERN POWER SYSTEM PROTECTION**						
Course Code	**22EEU701**						
Category	**Integrated Professional Core Course (IPCC)**						
Scheme and Credits	No. of Hours/Week					Total teaching hours	Credits
	L	T	P	SS	Total		
	03	**00**	**02**	**00**	**05**	**39+14**	**04**
CIE Marks: **30+20(Lab)**	SEE Marks: **50**		Total Max. marks:**100**		Duration of SEE: **03 Hours**		

COURSE OBJECTIVE:

1. To introduce conventional protection and protection devices for power systems
2. To learn modern protection and protection devices for power systems.
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 I **10 hours**

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, 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.

UNIT II **8 hours**

Protective Relaying Operating principles: Requirement of Protective Relaying, Zones of protection, primary and backup protection, Essential qualities of Protective Relaying, 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 protection - such as non-pilot over-current protection of transmission lines, transformer protection, non-pilot distance protection of transmission lines, rotating machinery protection.

UNIT III **7 hours**

Embedded protection systems: General architecture & Essential requirements of an embedded protection system, model/component based approach in designing an embedded system; microprocessor architecture and digital signal processor architecture & requirements of – DMA, ADC, MAC, memory, and communication controllers.

UNIT IV **7 hours**

Phasor measurement, metering and records (DSP techniques): Definition of a phasor; DSP primer: simultaneity in sampling, sampling theorem, aliasing, comparison betweeen – FIR, IIR, symmetric FIR filters, PMU, Phasor measurement algorithm; frequency tracking algorithms; Introduction to synchro-phasor measurement.

UNIT V **7 hours**

Substation Automation Concepts & Communication stacks: Introduction to substation communication architecture; 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, and IEC 61850. A brief introduction to MODBUS; A brief introduction to IEC 61850.

TEACHING LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos, Laboratory experiments

Protection Laboratory:

Unit No.	Syllabus Content
1	Current-time characteristics of fuse.
2	Operating characteristics of (i) Electromechanical microprocessor based (numeric) over/under voltage relay.
3	Operating characteristics of microprocessor based (numeric) over –current relay.
4	Operating characteristics of microprocessor based over/under voltage relay.
5	Operating characteristics of microprocessor based over/under voltage relay.
6	Operating characteristics of microprocessor based (numeric) over/under voltage relay.
7	Motor protection scheme-fault studies.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: list, define and explain the mechanisms/theories involved in circuit interruption and protection devices. (L1 & L2)

CO2: explain the characteristics and working of various protective devices, protection schemes and solve problems related to protection devices. (L2)

CO3: apply the basic concepts of embedded protection systems and communication to power system protection. (L3)

CO4: understand sampling and its importance, filters and apply phasor measurement techniques in protection systems. (L4)

CO5: understand the requirements of international standards related to protective Relaying and justify their use in protection systems. (L5)

TEXT BOOKS

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

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

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

4. Sunil S.Rao, Khanna Publishers **"Switchgear & Protection"**, 13th Edition, 2008.

5. T.S.Madava rao**, "Power System protection-static relays with microprocessor applications"**, TMH second edition**,** 2004**.**

REFERENCE BOOKS

1. Soni, Gupta & Bhatnagar, **"A Course in Electrical Power"**, Dhanapatirai publications.

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

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

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

5. BHEL **"Handbook of Switchgears",** TMH, 5th reprint, 2008

ONLINE RESOURCES

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

https://onlinecourses.nptel.ac.in/noc22_ee101/preview

SCHEME FOR EXAMINATIONS

(i) The question paper will have ten full questions carrying equal marks.
(ii) Each full question will be for 20 marks.
(iii) There will be two full questions from each module.
(iv) Each full question will have sub-questions (subject to a maximum of four sub-questions)
(v) The students have to answer five full questions, selecting one full question from each module.

MAPPING of COs with POs and PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2		**1**			**1**		**1**		1	3	1	1
CO2	3	3	2		**1**			**1**		**1**		1	3	1	1
CO3	3	3	2		**1**			**1**		**1**		1	3	1	1
CO4	3	3	2		1			1		1		1	3	1	1
CO5	3	3	2		1			1		1		1	3	1	1

Strength of correlation: Low-1, Medium- 2, High-3

Course Title	**COMPUTER METHODS IN POWER SYSTEM ANALYSIS**						
Course Code	**22EEU702**						
Category	**IPCC**						
Scheme and Credits	No. of Hours/Week					Total teaching + Lab hours	Credits
	L	T	P	SS	Total		
	03	**00**	**02**	**00**	**05**	**40+25 = 65**	**04**
CIE Marks: **30T+20L**	SEE Marks: **50**		**Total Max. marks:100**		Duration of SEE: **03 Hours**		

COURSE OBJECTIVE:

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 iterative techniques.
4. Evaluate economic operation of power system
5. Estimate the stability of power system

UNIT I **8 hours**
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 Bus voltage equations in terms network impedance and current injection.
UNIT II **8 hours**
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).
UNIT III **8 hours**
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.
UNIT IV **8 hours**
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
UNIT V **8 hours**
Impedance Matrices and Transient Stability Studies: Modification of Z_{BUS} for branch and links addition. Impedance matrix by step by step building algorithm (numerical problems without mutual coupling elements) Introduction to transient stability. Numerical solution of swing equation by Point-by-point method, modified Euler's method, Milne's Method, Runge-Kutta method.

Sl. No	**Laboratory Component:-** Using MATLAB & Mi-Power/ E-Tap simulation package	**# hours**
i)	**Using MATLAB -**	
1	Y-bus formation for power system without mutual coupling by inspection method.	2
2	Y-bus formation of power system by singular transformation method.	2
3	Power angle Characteristics for (i) salient and (ii) non-salient pole synchronous machines. Determination of reluctance power, excitation emf and regulation	2

4	Formation of Z bus formation by Z bus building algorithm (without mutual coupling)	2
5	Determination of bus currents, bus voltages, bus power and line flows for a specified system.	2
ii)	**Using simulation package**	
6	Load flow analysis for a system using Gauss siedal methods	2
7	Load flow analysis for a system using Newton Raphson & Fast Decoupled methods	2
8	Determine sequence components and fault currents and voltages of transmission system under various short circuit fault.	2
	Other Experiments	
1	Load flow analysis of power system using Gauss Seidal method- using Matlab	
2	Formation of Jacobian for a system with buses less than four by MAT Lab	
3	Determine i) Swing curve ii) critical clearing time for a single machine connected to infinite bus under 3-phase Fault	
4	Optimal generator scheduling for thermal power plants including B coefficients	
5	Optimal generator scheduling for thermal power plants.(2 units & 3 units)	

TEACHING LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos

COURSE OUTCOMES: On completion of the course, student should be able to:

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

TEXT BOOKS

1. Stag G. W. and EI-Abiad A. H., **Computer Methods in Power System Analysis,** McGraw Hill International Student Edition. 1968
2. I.J.Nagrath and D.P.Kothari, "Modern Power System Analysis", 3rd Edition TMH, 2003
3. Uma Rao, Computer Techniques in Power System, IK International Publishing House pvt. Ltd., Bangalore
4. Lab manual for practical's

REFERENCE BOOKS

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. Naser A and Boldea I, "Linear Electric Motors: Theory", First Edition,Prentice, 2003
5 Dhar R.N, **Computer Aided Power System Operations and Analysis**"- TMH, 1984.
6. Nagrath I. J., and Kothari D. P, **Modern Power System Analysis,** TMH, 3rd Edition, 2003.

ONLINE RESOURCES

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

SCHEME FOR EXAMINATIONS

i. The question paper will have ten full questions carrying equal marks.
ii. Each full question will be for 20 marks.
iii. There will be two full questions from each module
iv. Each full question will have sub-questions (subject to a maximum of four sub-questions)
v. The students have to answerfive full questions, selecting one full question from each module.
vi. Only CIE evaluation for lab component no SEE for lab

MAPPING of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3			2							2	3	2	1
CO2	3	3			2							2	3	2	1
CO3	3	3			2							2	3	2	1
CO4	3	3			2							2	3	2	1
CO5	3	3			2							2	3	2	1

Strength of correlation: Low-1, Medium- 2, High-3

Course Title	**ELECTRICAL MACHINE DESIGN**						
Course Code	**22EET703**						
Category	**Professional Elective Course (PCC)**						
Scheme and Credits	No. of Hours/Week					Total teaching hours	Credits
	L	T	P	SS	Total		
	03	**02**	**00**	**00**	**05**	**39+13**	**04**
CIE Marks: **40+5(A)+5(GA)**	SEE Marks: **50**		Total Max. marks:**100**		Duration of SEE**: 03 Hours**		

COURSE OBJECTIVE

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

UNIT I **12 hours**

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.

UNIT II **10 hours**

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).

UNIT III **10 hours**

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.

UNIT IV **10 hours**

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.

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UNIT V **10 hours**

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.

TEACHING LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos.

Course Outcomes:

CO1: Apply the basic principles of design and to select the best materials for use in electrical machines.
CO2: Explain design concepts of static electrical machines.
CO3: Analyse the design concepts of rotating ac and dc electrical machines for the optimized performance.
CO4: Examine the design problems of static electrical machines.

CO5: Solve the design problems of rotating ac and electrical machines for the optimized performance.

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. 2002
2. A. Shanmugasundarm, G. Gangadharan, R. Palani, "Design Data Handbook".

Web Links.

1. https://www.quora.com/Where-can-I-get-a-A-K-Sawhney-PDF-of-a-course-inelectrical-machine-design
2. https://books.google.co.in/books/about/Design_Of_Electrical_Machines.html?id=7mTRGAAA

SCHEME FOR EXAMINATIONS:

(i) The question paper will have ten full questions carrying equal marks.
(ii) Each full question will be for 20 marks.
(iii)There will be two full questions from each module.
(iv) Each full question will have sub-questions (subject to a maximum of four sub-questions)
(vi) The students have to answer five full questions, selecting one full question from each module.

MAPPING of COs with POs and PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2							2			3		2
CO2	3	3	2							2			3		2
CO3	3	3	2							2			3		2
CO4	3	3	2							2			3		2
CO5	3	3	2							2			3		2
Strength of correlation: Low-1, Medium- 2, High-3															

Course Title	**INDUSTRIAL AUTOMATION AND ROBOTICS**						
Course Code	**22EET704A**						
Category	**Professional Elective Course (PEC)**						
Scheme and Credits	No. of Hours/Week					Total teaching hours	Credits
	L	T	P	SS	Total		
	03	00	00	00	03	39	03
CIE Marks + A(5)+GA(5): 50M	**SEE Marks: 50**		**Total Max. marks=100**		**Duration of SEE: 03 Hours**		

COURSE OBJECTIVE:

1. To learn about basic component of robots such as sensor, actuators, and feedback devices.
2. To know about anatomy, different configuration and motion of robots.
3. The objective of this subject is to impart basic knowledge on automation in Industries.
4. Able to understand the numerical control of robotics
5. Will be able to get the knowledge of industrial applicable robotics

UNIT I **08 hours**

INTRODUCTION TO AUTOMATION - need-types, basic elements of an automated system, levels of automation- computer process control, forms of computer process control, input/output devices for discrete data, overview of material handling equipment.

UNIT II **08 hours**

NUMERICAL CONTROL: Introduction-numerical control procedure, numerical control coordinate systems, elements of numerical control systems, classification of numerical control systems, advantages and dis-advantages of numerical control systems, applications of numerical control, numerical control manual part programming, apt language.

UNIT III **08 hours**

MANUAL ASSEMBLY LINES AND TRANSFER LINES: Fundamentals of manual assembly lines and automated production lines, alternative assembly systems, design for assembly, applications of automated production lines, analysis of transfer lines with no internal storage, analysis of transfer lines with storage buffers.

UNIT IV **08 hours**

INTRODUCTION TO INDUSTRIAL ROBOTS: Robotics definition - robot configurations, robot anatomy, joint system, types of joints, work volume, robot drive systems, precision of movement, robotic sensors and actuators, end effectors, grippers, different types of grippers.

UNIT V **08 hours**

MANIPULATOR KINEMATICS: representation of position and orientation of body, transformation of rigid body, homogenous transformation, the manipulator kinematics, d-h parameters, 2r and 3r mechanism d-h analysis, forward and inverse kinematics.

TEACHING LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Understand fundamental aspects of automation in industries.
CO2: Understand the basics of Numerical Control machines and part programming of simple geometries
CO3: Understand fundamental of automatic assembly line and production line.
CO4: Learn robot anatomy of robot, configuration of different robots, and Describe construction and working of different types robots
CO5: Analyze position and orientation of body

TEXT BOOKS

1. Automation, Production Systems and CIM, Mikell P. Groover, Prentice-Hall of India Pvt. Ltd, 2016.
2. Industrial Robotics -Technology, Programming and Applications (SIE), Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel, Ashish Dutta, McGraw-Hill 2nd Edition, 2017.

3. Introduction to robotics: analysis, control, applications. Niku, S. B, John Wiley & Sons, 2020.

REFERENCE BOOKS

1. Robotics: Control Sensing, K.S.Fu., R.C.Gonzalez, C.S.G. Lee, Vision and Intelligence Indian Edition, McGraw Hill Book Co., 2008.
2. An introduction to robot technology. Coiffet, P., & Chirouze, M., Springer Science & Business Media, 2012.
3. Robotics: fundamental concepts and analysis, Ghosal, A, Oxford university press, 2006 .
4. Robotics and Control, Mittal R.K & Nagrath IJ, McGraw-Hill, 2017.
5. Introduction to Robotics, Craig, John J, 2005.

ONLINE RESOURCES

1.https://nptel.ac.in/courses/108105063
2.https://nptel.ac.in/courses/112101098
3. https://nptel.ac.in/courses/112105249

MAPPING of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1							1	2	2	2
CO2	3	2	2	1	1							1	2	2	2
CO3	3	2	2	1	1							1	2	2	2
CO4	3	2	2	1	1							1	2	2	2
CO5	3	2	2	1	1							1	2	2	2
Strength of correlation: Low-1, Medium- 2, High-3															

Course Title	**POWER SYSTEM OPERATION AND CONTROL**						
Course Code	**22EET704B**						
Category	**Professional Elective Course (PEC)**						
Scheme and Credits	No. of Hours/Week					Total teaching hours	Credits
	L	T	P	SS	Total		
	03	**00**	**03**	**00**	**03**	**40**	**03**
CIE Marks**: 40 + 5(A) + 5(GA)**	SEE Marks**: 50**		Total Max. marks**:100**		Duration of SEE**: 03 Hours**		

COURSE OBJECTIVE:

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 I **09 hours** **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)
UNIT II **08 hours** **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.
UNIT III **08 hours** **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.
UNIT IV **07 hours** **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.
UNIT V **08 hours** **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 and Linear sensitivity factors.

TEACHING LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos

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

CO1: Illustrate Economic operation of power system and importance of SCADA Systems.

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: List out the importance of the need of secondary memory and to protect the basic OS principles.

TEXTBOOKS:

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.
5. Olle J Elgerd, " Electric Energy Systems", 2nd edition, TMH, 2008

REFERENCE 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

MAPPING of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3						2	1		1			3		2
CO2	3						2	1		1			3		2
CO3	3						2	1		1			3		2
CO4	3						2	1		1			3		2
CO5	3						2	1		1			3		2
Strength of correlation: Low-1, Medium- 2, High-3															

Course Title	**FACTS CONTROLLERS AND HVDC TRANSMISSION**						
Course Code	**2EEET704C**						
Category	**PEC**						
Scheme and Credits	No. of Hours/Week					Total teaching + Lab hours	Credits
	L	T	P	SS	Total		
	03	**00**	**00**	**00**	**03**	**40**	**03**
CIE Marks: **40+5(A)+5(GA)**	SEE Marks: **50**		Total Max. marks:**100**		Duration of SEE: **03 Hours**		

COURSE OBJECTIVE:

1. To know the importance of compensation in transmission lines and the concepts of FACTS devices.
2. To study the concepts of TCSC.
3. To illustrate the applications of SVC and emerging FACTS technology
4. To Understand HVDC technology.
5. To Understand HVDC controller

UNIT I **8 hours**

Introduction: Background, electrical transmission networks, conventional control mechanisms, Flexible AC Transmission Systems (FACTS), emerging transmission networks.

Power Transmission Systems: Reactive power, uncompensated transmission lines, passive compensation.

UNIT II **8 hours**

Principles of Conventional Reactive-Power Compensators thyristor-controlled reactor (TCR).

The thyristor-switched capacitor (TSC), the thyristor-switched capacitor–thyristor- controlled reactor (TSC–TCR).

Concepts of SVC Voltage Control and Applications: Introduction, voltage control. Increase in steady-state power-transfer capacity, enhancement of transient stability

UNIT III **8 hours**

The Thyristor-Controlled Series Capacitor (TCSC) and Applications: Series compensation, the TCSC controller, operation of the TCSC, the TSSC, capability characteristics.

EMERGING FACTS CONTROLLERS: Introduction, the STATCOM, the SSSC, Unified Power Flow Controllers (UPFC): principle of operation, applications

UNIT IV **8 hours**

HVDC Technology: Introduction, Advantages of HVDC Systems, HVDC System Costs, Overview and Organization of HVDC Systems, Review of the HVDC System Reliability, HVDC Characteristics and Economic Aspects.

Power Conversion: Thyristor, 3-Phase Converter, 3-Phase Full Bridge Converter, 12-Pulse Converter

UNIT V **8 hours**

Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability.

Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability.

TEACHING LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Understand the growth of complex electrical power networks, the lack of controllability of the active- and reactive-power flows

CO2: Describe the concepts of SVC and TCSC

CO3: Explain the use of emerging FACTS controllers

CO4: Analyse economics of HVDC technology.

CO5: Analyse HVDC converters and controllers

.

TEXT BOOKS

1 Mohan Mathur, R, Rajiv. K. Varma, "Thyristor – Based FACTS Controllers for Electrical Transmission Systems", Third Edition, IEEE press and John Wiley & Sons, 2014

2 Narain G Hingorani and L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", 1st edition, Wiley India, 2017

3. Chan-Ki Kim et al " HVDC Transmission: Power Conversion Applications in Power Systems" Wiley, 2009

REFERENCE BOOKS

1.K.R Padiyar, "FACTS Controllers in Power Transmission and Distribution", 1st edition, New Age International publisher, 2007

2.Mathur, R.M. and Verma, R.K., Thyristor based FACTS controllers for Electrical Transmission Systems, IEEE Press (2002).

3.K. R. Padiyar, "HVDC Power Transmission Systems", New Age International, 2012

ONLINE RESOURCES

1.https://books.google.co.in/books/about/Flexible_Ac_Transmission_Systems_FACTS.html?id=AqPr4JyDWg0C

2. Prof.S.N.Singh "High Voltage DC Transmission",http://nptel.iitm.ac.in

3 Prof.S.N.Singh "High Voltage DC Transmission",http://nptel.iitm.ac.in

SCHEME FOR EXAMINATIONS

(i) The question paper will have ten full questions carrying equal marks.

(ii) Each full question will be for 20 marks.

(iii) There will be two full questions from each module.

(iv) Each full question will have sub-questions (subject to a maximum of four sub-questions)

(v) The students have to answer five full questions, selecting one full question from each module.

MAPPING of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO11	3	3						1		1		1	3		1
CO2	3	3						1		1		1	3		1
CO3	3	3						1		1		1	3		1
CO4	3	3						1		1		1	3		1
CO5	3	3						1		1		1	3		1
Strength of correlation: Low-1, Medium- 2, High-3															

Course Title	**ENERGY STORAGE SYSTEMS**						
Course Code	**22EET704D**						
Category	**PEC**						
Scheme and Credits	No. of Hours/Week					Total teaching + Lab hours	Credits
	L	T	P	SS	Total		
	03	**00**	**00**	**00**	**03**	**40**	**03**
CIE Marks: **40+5(A)+5(GA)**	SEE Marks: **50**		Total Max. marks:**100**		Duration of SEE: **03 Hours**		

COURSE OBJECTIVE:

1. To acquaint with the principles of energy storage as a structural unit of power system.
2. To analyse the working and power extraction systems in thermal and mechanical energy storage systems
3. To analyse the working and power extraction systems in electrical, chemical and electrochemical energy storage systems
4. To analyse various energy storage applications
5. To analyse the optimization regimes used for energy storage in power system

UNIT I **8 hours**
Energy Storage as a structural unit of power system: General considerations, energy and power balance in a storage unit, mathematical and econometric model of storage. Overview of storage types, storage operating cost, energy and power density, power conditioning and power quality.
UNIT II **8 hours**
Energy Storage Techniques-1: Thermal energy storage system – power generation techniques (block diagram), underground layer heat storage, thermal energy storage mechanisms, limitations of storage design, power extraction methods. Flywheel Storage – maximum mass density and useful energy per mass unit, application of flywheel energy storage.
UNIT III **8 hours**
Energy Storage Techniques-2**:** Hydrogen and other synthetic fluid storage**:** synthetic storage media, storage containment for hydrogen, the hydride concept**.** Electrochemical energy storage**:** secondary batteries **–** lead acid battery & sodium Sulphur battery, fuel cell, storage unit assembly, thermal regime, power extraction system**.** Capacitor bank storage**:** capacitor storage media, power extraction system**.**
UNIT IV **8 hours**
Electric energy storage applications: power application versus energy application, capacity application versus energy application, electric supply applications – electric energy time shift and electric supply capacity, grid system applications – transmission support and transmission congestion relief, end user/utility customer applications- electric service reliability, electric service power quality.
UNIT V **8 hours**
Optimizing regimes for energy storage in a power system: storage regimes in the power system, optimal regime criterion, simplified one node system, algorithm for the optimal regime.

TEACHING LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1. Understand about the energy and power concepts in a storage unit

CO2. Understand the thermal and mechanical energy storage techniques

CO3. Understand the electrical, chemical and electrochemical energy storage techniques

CO4. Relate the above concepts with various applications of energy storage
CO5. Understand the importance of optimizing the energy storage and the regimes used.

TEXT BOOKS

1. 1.A. G. Ter-Gazarian, "Energy Storage for Power Systems", Institution of Engineering and Technology, 2011
2. 2.James M. Eyer, Joseph J. Iannucci and Garth P. Corey, "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004

REFERENCE BOOKS

1. David Elliott, "Energy Storage Systems", IOP Publishing Ltd 2017

ONLINE RESOURCES

1. https://www.elsevier.com/books/grid-scale-energy-storage-systems-and-applications/wu/978-0-12-815292-8
2. https://digital-library.theiet.org/content/books/po/pbpo146e

SCHEME FOR EXAMINATIONS

1. The question paper will have ten full questions carrying equal marks.
2. Each full question will be for 20 marks.
3. There will be two full questions from each module.
4. Each full question will have sub-questions (subject to a maximum of four sub-questions)
5. The students have to answer five full questions, selecting one full question from each module.

MAPPING of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3						1		1		1		1	2
CO2	3	3						1		1		1		2	2
CO3	3	3						1		1		1	1	2	2
CO4	3	3						1		1		1	2	1	2
CO5	3	3						1		1		1	2	2	2

Strength of correlation: Low-1, Medium- 2, High-3

Course Title	**INDUSTRIAL DRIVES AND APPLICATION**						
Course Code	**22EET704E**						
Category	**Professional Elective Course (PEC)**						
Scheme and Credits	No. of Hours/Week					Total teaching hours	Credits
	L	T	P	SS	Total		
	03	**00**	**00**	**00**	**03**	**40**	**03**
CIE Marks: **40+5(A)+5(GA)**	SEE Marks: **50**		Total Max. marks:**100**		Duration of SEE**: 03 Hours**		

COURSE OBJECTIVE:

1. To define electric drive, its parts, advantages and explain choice of electric drive.
2. To explain dynamics, power rating calculations and modes of operation of DC motor drives.
3. To analyze the performance and control of induction motor drives under different conditions.
4. To understand the control of synchronous motor and stepper motor drives.
5. To understand the control of special motor drives, & applications of electrical drives in the industry.

UNIT I **08 hours**

Electrical Drives: Electrical Drives, Advantages of Electrical Drives. Parts of Electrical Drives, Choice of Electrical Drives, Status of DC and AC Drives. Dynamics of Electrical Drives: Fundamental Torque Equations, Multi-Quadrant Operation. Equivalent values of Drive parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization

UNIT II **08 hours**

Control Electrical Drives: Modes of Operation, Speed Control and Drive Classifications, Closed loop Control of Drives. Phase locked Loop control (PLL)

Selection of motor power rating: Classes of motor duty Determination of motor rating

Dc motor drives: DC motors and performance of separately excited and self-excited machines, shunt series and compound motors, starting and braking, regenerative, dynamic braking, speed control armature control drives. Controlled rectifier fed DC drives, single phase fully controlled and half – controlled rectifier control of dc separately excited motors

UNIT III **08 hours**

Induction Motor Drives: Analysis and Performance of Three Phase Induction Motors, Operation with Unbalanced Source Voltage and Single Phasing, Operation with Unbalanced Rotor Impedances, Starting, Braking, Transient Analysis. Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources. Voltage Source Inverter (VSI) Control, Cycloconverter Control, Closed Loop Speed Control for VSI Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source inverter (CSI) Control, Comparison of VSI and CSI, current regulated voltage source inverter control

UNIT IV **08 hours**

Synchronous Motor Drives: Operation from fixed frequency supply-starting, synchronous motor variable speed drives, variable frequency control of multiple synchronous motors. Self-controlled synchronous motor drive employing load commutated thyristor inverter, Starting Large Synchronous Machines,

UNIT V **08 hours**

Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless DC Motor Drives.

Stepper Motor Drives: Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor..

Energy conservation in Electrical Drives: Losses in electrical drive system, Measures for energy conservation in Electrical drives.

Industrial Drives: Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools, use of single to three phase semiconductor converters in rural applications.

TEACHING LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos

Course Outcomes:

CO1 Apply the basic principles of drives, analysis of quadrant operation of drives
CO2. Understand DC machine principles and to apply different operation techniques of drives
CO3. Analyze the performance & control of AC motor drives using controlled Rectifiers & Circuits.
CO4. Analyze the performance & synchronous motor drives using controlled circuits.
CO5. Understand special machines drive system & energy conservations in drives application of drives in Industry.

Text Books.

1 Fundamentals of Electrical Drives Gopal K. Dubey Narosa Publishing 2nd Edition, 2001

2 Electrical Drives: Concepts and Applications for Industrial Drives Vedum Subrahmanyam McGraw Hill 2nd Edition, 2011

Reference Text Books.

1 Electric Drives N.K De, P.K. Sen PHI Learning 1 st Edition, 2009

SCHEME FOR EXAMINATIONS

1. The question paper will have ten full questions carrying equal marks.
2. Each full question will be for 20 marks.
3. There will be two full questions from each module.
4. Each full question will have sub-questions (subject to a maximum of four sub-questions)
5. The students have to answer five full questions, selecting one full question from each module.

MAPPING of COs with POs and PSOs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1										2		
CO2	3	3	2	2	2	1	1		1		1	1	3	1	1
CO3	3	3	2	2	2	1	1		1		2	2	3	2	1
CO4	3	2	3	2	2	1	1		1		2	2	3	2	1
CO5	3	2	1				1						2	1	

Strength of correlation: Low-1, Medium- 2, High-3

Course Title	**BIG DATA ANALYTICS IN POWER SYSTEMS**						
Course Code	**22EET704F**						
Category	**Professional Elective Course (PEC)**						
Scheme and Credits	No. of Hours/Week					Total teaching hours	Credits
	L	T	P	SS	Total		
	03	**00**	**03**	**00**	**03**	**40**	**03**
CIE Marks**: 40 + 5(A) + 5(GA)**	SEE Marks**: 50**		Total Max. marks**:100**		Duration of SEE**: 03 Hours**		

COURSE OBJECTIVE:

1. To define big data and to explain big data application and analytics to power systems.
2. To explain the role of big data in smart grid communications and optimization of big data in electric power systems.
3. To explain security methods for the infrastructure communication and data mining methods for theft detection in power systems.
4. To explain the application of unit commitment method in the control of smart grid.
5. To explain protection algorithm for transformer based on data pattern recognition.

UNIT I **08 hours**

Introduction: Big Data, Future Power Systems.

Big Data Application and Analytics in a Large - Scale Power System: Introduction, General Applications of Big Data, Algorithms for Processing Big Data, Application of Big Data in Power Systems.

UNIT II **08 hours**

Role of Big Data in Smart Grid Communications: Introduction, The Grid Modernization, The Grid Interconnection with the Internet of Things, Data Traffic Pattern in a Smart Grid Environment, The Massive Flow of Information in a Smart Scenario ,The Volume of Generated Data in a Smart Distribution System: A Case of Study.

Big Data Optimization in Electric Power Systems: Introduction, Background, Scientometric Analysis of Big Data, Big Data and Power Systems, Optimization Techniques Used in the Big Data Analysis.

UNIT III **08 hours**

Security Methods for Critical Infrastructure Communications: Introduction, Effects of Successful Communication System Threats, General Communication System Operations, Industrial Control Networks and Operations, High-Level Communication System Threats, Cyber Threats and Security.

UNIT IV **08 hours**

Data - Mining Methods for Electricity Theft Detection: Introduction, Transmission and Distribution System Losses, Electricity Theft Methods, Data Mining and Electricity Theft, Issues and Directions in Electricity Theft-Related Data-Mining Research.

UNIT V **08 hours**

Unit Commitment Control of Smart Grids: Introduction, Renewable Energy Resources, The Unit Commitment Problem, A Multi-agent Architecture, Illustrative Example.

TEACHING LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos

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

CO1: Understand the concepts of big data and analyze its applications, analytics, and processing algorithms in large-scale power systems.

CO2: Explain the role of big data in smart grid communication systems and apply optimization techniques for managing large volumes of power system data.

CO3: Analyze various cyber security threats in critical infrastructure and communication networks in smart grids.
CO4: Apply data mining techniques for electricity theft detection.
CO5: Examine unit commitment issues in smart grids with high renewable energy integration.

TEXT BOOKS:

1. Big Data Analytics in Future Power Systems. Ahmed F. Zobaa and Trevor J. Bihl, CRC Press, 2019.

REFERENCE BOOKS:

1. Big Data Application in Power Systems, Reza Arghandeh and Yuxun Zhou,Elsevier, 2018.
2. Smart Grid using Big Data Analytics: A Random Matrix Theory Approach, Robert C. Qiu and Paul Antonik John Wiley & Sons Ltd, 2017
3. Big Data Applications and Use Cases,Patrick C. K. Hung Springer International Publishing Switzerland 2016.

Web Links

1. https://www.youtube.com/watch?v=Tgg4-CL-qxs
2. https://www.youtube.com/watch?v=kSRwTUIioMI
3. https://www.researchgate.net/publication/343759401_Role_of_Big_Data_Analytics_in_Power_System_Application

SCHEME FOR EXAMINATIONS

1. The question paper will have ten full questions carrying equal marks.
2. Each full question will be for 20 marks.
3. There will be two full questions from each module.
4. Each full question will have sub-questions (subject to a maximum of four sub-questions)
5. The students have to answer five full questions, selecting one full question from each module.

MAPPING of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				2								3	2	
CO2	3				2								3	2	
CO3	3				2								3	2	
CO4	3				2								3	2	
CO5	3				2								3	2	
Strength of correlation: Low-1, Medium- 2, High-3															

Course Title	**ARTIFICIAL INTELLIGENCE FOR POWER SYSTEM APPLICATION**						
Course Code	**21EET704G**						
Category	**PEC**						
Scheme and Credits	No. of Hours/Week					Total teaching + Lab hours	Credits
	L	T	P	SS	Total		
	03	**00**	**00**	**00**	**03**	**40**	**03**
CIE Marks: **40+5(A)+5(GA)**	SEE Marks: **50**		Total Max. marks:**100**		Duration of SEE: **03 Hours**		

COURSE OBJECTIVE:

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 I	**08 hours**
Sparsity oriented Programming: Introduction, physical structure and sparsity, pivoting, conservation of sparsity by optimal ordering of buses, schemes for ordering, UD table storage scheme. Numerical examples	
UNIT II	**08 hours**
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.	
UNIT III	**08 hours**
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. Application of Fuzzy logic in power systems.	
UNIT IV	**08 hours**
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.	
UNIT V	**08 hours**
Intelligent Optimization Techniques: Introduction to Intelligent Optimization, Genetic Algorithm: Types of reproduction operators, crossover & mutation, Simulated Annealing Algorithm, Particle Swarm Optimization (PSO), Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation,	
TEACHING LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos	

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1 Understand the basic issues of knowledge representation of Sparsity oriented programming.
CO2 Apply basic knowledge of AI to solve simple problems
CO3 Learn 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. 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 BOOKS

1. Elaine Rich, Kevin Knight, "Artificial Intelligence", second edition, TMH publisher, 2008

1 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

ONLINE RESOURCES

1 news.mit.edu/topic/artificial

2 reddit.com/r/artificial

SCHEME FOR EXAMINATIONS

(i) The question paper will have ten full questions carrying equal marks.
(ii) Each full question will be for 20 marks.
(iii) There will be two full questions from each module.
(iv) Each full question will have sub-questions (subject to a maximum of four sub-questions)
(v) The students have to answer five full questions, selecting one full question from each module.

MAPPING of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3					1			1		2		2	1	
CO2	3		2			1			1				3	2	
CO3			3			2							2		
CO4			2			1			2		3			3	1
CO5			3			1			2		2		3	2	
Strength of correlation: Low-1, Medium- 2, High-3															

Course Title	**ELECTRIC VEHICLE TECHNOLOGY**						
Course Code	**22EET705A**						
Category	**OEC**						
Scheme and Credits	No. of Hours/Week					Total teaching + Lab hours	Credits
	L	T	P	SS	Total		
	03	**00**	**00**	**00**	**03**	**40**	**03**
CIE Marks: **40+5(A)+5(GA)**	SEE Marks: **50**		Total Max. marks:**100**		Duration of SEE: **03 Hours**		

COURSE OBJECTIVE:

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 I **8 hours**

Introduction to Electric Vehicle: Historical background of hybrid and electric vehicles, benefits of EVs, Classification of EVs, Challenges of a typical battery electric vehicle. IC engine based technology, design requirements of typical EV motor classification of EV motors. energy source technologies; Regone plot, types and comparison of batteries, ultra-capacitors/ ultra-fly wheels, fuel cells, on-board renewable energy sources.

UNIT II **8 hours**

EV Battery Charging Technologies: Charging schemes, charging algorithms, medium of charge transfer, types of wireless power transfer, battery management system.
Vehicle to grid technologies, applications to power system
EV Systems and Configuration: Typical BEV configuration, hybridisation of energy sources, modes of operation, types and comparison of HEV, power train efficiency in EVs and ICEVs.

UNIT III **8 hours**

Vehicle Dynamics 1: Introduction, tractive effort, aerodynamic drag, the resistance offered by tire, rolling resistance etc.; gradient and hill climbing force, vehicle road load force, gradability, acceleration force. Tractive effort.

UNIT IV **8 hours**

Vehicle Dynamics 2: Dynamic equation with constant Fte- constant tractive effort, terminal velocity, distance, time and energy equations; dynamic equation variable Fte- derivation of different dynamic equations with variable FTE- variable tractive effort and different regions of vehicle speeds.

UNIT V **8 hours**

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. Driving cycle, Range modelling.

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: Estimate the transient stability of the power system through different numerical methods

REFERENCE 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.
3 Tom Denton. , "Electric And Hybrid Vehicles" Routledge / Taylor & Francis Group 2016

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

ONLINE RESOURCES

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

2 https://youtu.be/Ay-4AZTnTEQ Electric Vehicle Part -1,Dr Amit Jain, IIT Delhi

3 https://nptel.ac.in/courses/108/102/108102121/

SCHEME FOR EXAMINATIONS

1 The question paper will have ten full questions carrying equal marks
2 Each full question will be for 20 marks
3 There will be two full questions from each module
4 Each full question will have sub-questions (subject to a maximum of four sub-questions)
5 The students have to answer five full questions, selecting one full question from each module

MAPPING of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO11	3	3	2		1							1		2	2
CO2	3	3		1	2	1								1	1
CO3	3				2						1	1	1	2	1
CO4	4	3			1	1							1	2	2
CO5	4	3		3				3					3	3	3
Strength of correlation: Low-1, Medium- 2, High-3															