Dr. Ambedkar Institute of Technology Department of Electrical and Electronics Engineering

The NAAC documents enclosed are verified and approved.

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Bengaluru-580056

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

| Sl | Subject Code | Subject title | Mapped to |
|-----|--------------|--|----------------------------------|
| No | | | Employability/Entrepreneur/Skill |
| 1. | 20EPE12 | Power Semiconductor Devices and Components | Employability |
| 2. | 20EPE13 | Solid State Power Controllers | Employability |
| 3. | 20EPE14 | Modelling and Simulation of Power Electronics Systems | Entrepreneur |
| 4. | 20EPE151 | Embedded Systems | Skill |
| 5. | 20EPE152 | Advanced Control Systems | Skill |
| 6. | 20EPE161 | PWM converters and applications | Employability |
| 7. | 20EPE162 | MPPT in solar systems | Employability |
| 8. | 20EPE163 | Electric Vehicle Technology | Entrepreneur |
| 9. | 20EPEL17 | Power Electronics Laboratory-1 | Skill |
| 10. | 20EPE21 | AC and DC Drives | Skill |
| 11. | 20EPE22 | Switched Mode Power Conversion | Employability |
| 12. | 20EPE23 | Power Electronics System Design Using Linear ICs | Skill |
| 13. | 20EPE24 | HVDC power Transmission | Employability |
| 14. | 20EPE263 | DSP applications to drives | Skill |

Defaleelel & BOS Chairman

Principal

Subject Title : POWER SEMICONDUCTOR DEVICES AND COMPONENTS

Sub.Code:20EPE12No. of Credits:03=03:0:0 (L - T - P)Exam Duration:03 HrsCIE+Asmt+SS+GA+SEE=30+10+5+5+50=100Course Learning Objectives:

No. of Lecture Hours/Week : 03 Total No.of Contact Hours:39

1 To analyse the working of basics power semiconductor devices

- 2 To analyse the working of power BJT and power MOSFET
- ³ To analyse the working of Thyristors, GTO and IGBT
- 4 To identify the types of protection circuits and their applications
- 5 To design the magnetic components based on the applications

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|---|----------------|-----------------------------|
| 1 | Basic Semiconductor Physics: Introduction, conduction processes in semiconductors pn junctions, charge control description of pn- junction operation, avalanche breakdown. Power Diodes: Introduction, Basic structure and I-V characteristics, breakdown voltage considerations, on – state losses, switching characteristics, schottky diodes. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 2 | Bipolar Junction Transistors: Introduction, vertical power transistor structures, I-V characteristics, physics of BJT operation, switching characteristics, breakdown voltages, second breakdown, on-state losses and safe operating areas. Power MOSFETs: Introduction, Basic structure, I-V characteristics, physics of device operation, switching characteristics, operating limitations and safe operating areas. TEXT 1 and TEXT 2. Reference Book 1 | 09 | L1,L2,L3. |
| 3 | Thyristors: Introduction, basic structure, I-V characteristics, physics of device operation, switching characteristics, methods of improving di/dt and dv/dt ratings. Gate Turn-Off Thyristors: Introduction, basic structure and I-V characteristics, physics of turn-off operation, GTO switching characteristics, over current protection of GTOs. Insulated Gate Bipolar Transistors: Introduction, basic structure, I- V characteristics, physics of device operation, latch up in IGBTs, switching characteristics, device limits and SOAs. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 4 | Emerging Devices and Circuits: Introduction, power junction field effect transistors, field-controlled thyristor, JFET-based devices | 07 | L1,L2,L3,L4 |

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| | versus other power devices, MOS-controlled thyristors, power integrated circuits, new semiconductor materials for power devices. Snubber Circuits: Function and types of snubber circuits, diode snubbers, snubber circuits for thyristors, need for snubbers with transistors, turn-off snubber, overvoltage snubber, turn-on snubber, snubbers for bridge circuit configurations, GTO snubber considerations. TEXT 1 and TEXT 2. Reference Book 1 | | |
| 5 | Component Temperature Control and Heat Sinks: Control of semiconductor device temperatures, heat transfer by conduction, heat sinks, heat transfer by radiation and convection. Design of Magnetic Components: magnetic materials and cores, copper windings, thermal considerations, analysis of a specific inductor design, inductor design procedures, analysis of a specific transformer design, eddy currents, transformer leakage inductance, transformer design procedure, comparison of transformer and inductor sizes. TEXT 1 and TEXT 2. Reference Book 1 | 07 | L1,L2,L3,L4 |

Note 1: Unit 1 to 5 will have internal choice

Note2: 1 Student has to submit one assignment per unit and is evaluated for 10 marks.

2 Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project and 5 marks for subject 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 working of various power semiconductor devices
- CO2 Understand the working and applications of BJT and Power MOSFET
- CO3 Understand the working and applications of Thyristors, GTO and IGBT
- CO4 Modeling and simulation of devices along with protection system
- CO5 Design the magnetic components based on the applications

Course Outcomes Mapping with Programme Outcomes.

| G1 N1 | G 0. | e Level of Blooms Taxonomy No. of hours of teaching | | | | | Р | rogra | mme | Outc | ome | | | |
|-------|----------------|---|--------------------------|---|---|---|---|-------|-----|------|-----|---|----|----|
| Sl.No | Course Outcome | Level of Blooms Taxonomy | No. of hours of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | 2 | 08 | | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| 2. | CO2. | 2 | 09 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| 3. | CO3: | 2 | 08 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| 4. | CO4: | 4 | 07 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| 5. | CO5: | 5 | 07 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| | Average CO | | | | 3 | 1 | 2 | | | | 2 | | 2 | 2 |

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

Course Outcomes Mapping with Programme Specific Outcomes

Text Books.

- 1 Ned Mohan, "Power Electronics Converters, Applications, and Design", Third Edition, Wiley Publisher, 2014
- 2 Muhammad H. Rashid, "Power Electronics: Circuits, Devices & Applications", 4th edition, Pearson publisher, 2014

Reference Text Books.

1 Daniel W Hart, "Power Electronics", 2nd edition, McGraw Hill publisher, 2013

Web Links.

1 <u>https://books.google.co.in/books/about/Fundamentals_of_Power_Semiconductor_Devi.html</u> <u>id=UiqrUWrYZXkC&redir_esc=y</u>

Subject Title : SOLID STATE POWER CONVERTERS

Sub.Code:20EPE13No. of Credits:03=03:0:0 (L - T - P)Exam Duration:03 HrsCIE+Asmt+SS+SEE=30+10+05+05+50=100

No. of Lecture Hours/Week : 03 Total No.of Contact Hours:39

Course Learning Objectives:

- 1 To explain operating principle of various converters.
- 2 To control various inverters
- 3 To analyze and distinguish different types of inverters
- 4 To design different inverters and converters
- 5 To solve problems on different inverters

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|---|----------------|-----------------------------|
| 1 | Line Commutated Converters: Phase control, single phase semi- converter & fully controlled converter, three phase semi controlled & fully controlled converter, dual converters, effect of source inductance, single phase series converters, design of converter circuits. TEXT 1 and TEXT 2. | 8 | L1,L2, L3,L4 |
| 2 | Inverters: Principle of operation, performance parameters, single phase bridge inverters and three phase inverters. Current source inverter, comparison between VSI & CSI, series resonant inverters.TEXT 1 and TEXT3 | 7 | L1,L2,L3,L4 |
| 3 | Voltage Control of Inverters: Single/multiple, pulse/SPWM/ modified SPWM methods, voltage control of three phase inverter, SPWM/third harmonic PWM, harmonic reduction. TEXT 1 and TEXT 2. | 8 | L1,L2,L3 |
| 4 | Multilevel Inverters: Introduction, types, diode clamped multi-level inverters, features & applications. Capacitor clamped multilevel inverter, cascaded H-bridge multilevel inverter. TEXT 1 and TEXT 2 | 8 | L1,L2,L3 |
| 5 | DC-DC Converters: Principle of operation, analysis of step-down and step-up converters, Introduction to derived converters; transformer models, design of DC-DC Converters. TEXT 1 and Reference 1 | 8 | L1,L2,L3,L4 |

Note 1: Unit 1 to 5 will have internal choice

Note 2: Student has to submit one assignment per unit and is evaluated for 10 marks

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 To explain operating principle of various converters.
- CO2 To perform controlling of various inverters.

- CO3 To Analyze and distinguish different types of converters.
- CO4 To design different inverters and converters.
- CO5 To Solve problems on different converters.

Course Outcomes Mapping with Programme Outcomes.

| S1.No | Course | Level of Blooms | No. of hours | | | | Pro | gran | nme | Ou | tcor | ne | | |
|--------|------------|-----------------|--------------|---|---|---|-----|------|-----|----|------|----|----|----|
| 51.140 | Outcome | Taxonomy | of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | L1,L2 | 8 | 3 | 1 | 1 | | | | | | | | |
| 2. | CO2. | L1,L2,L4 | 7 | 1 | 3 | 1 | | | | | | | | |
| 3. | CO3: | L2,L4 | 8 | 1 | 3 | 1 | | | | | | | | |
| 4. | CO4: | L2,L4 | 8 | 1 | 1 | 3 | 1 | | | | | | | |
| 5. | CO5: | L2,L4 | 8 | | 1 | 3 | | | | | | | | |
| | Average CO | | | | 2 | 2 | 1 | | | | | | | |

Course Outcomes Mapping with Programme Specific Outcomes

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

Text Books.

- 1 Ned Mohan, Tore M. Undeland, William P. Robbins"**Power Electronics Converters, Applications, and Design**", Third Edition, Wiley India Pvt. Ltd, 2011
- 2 Rashid M.H, "Power Electronics Circuits Devices and Applications", 3rd Edition, Pearson, 2011.

Fang Lin Luo, Hong Ye, "Advanced DC/AC converters- Applications to Renewable Energy", 1st Edition, CRC2013.

Reference Text Books.

1 D K Bose"Modern Power Electronics & AC Drives", 1st edition, 2012

Web Links.

- 1 B. G. Fernandes" A course on Power Electronics" <u>http://nptel.ac.in/courses/108101038/</u>
- 2 Ramnarayan/Prof. L. Umanand "A course on Switched Mode Power Conversion") http://nptel.ac.in/courses/108108036
- 3 K. Gopakumar "A course on Industrial Drives Power Electronics" <u>http://nptel.ac.in/courses/108108077</u>

Subject Title : MODELING AND SIMULATION OF POWER ELECTRONICS SYSTEMS

Sub.Code:20EPE14

No. of Credits:03=03:0:0 (L - T - P)

Exam Duration:03 Hrs CIE+Asmt+SS+GA+SEE=30+10+5+5+50=100 Course Learning Objectives:

No. of Lecture Hours/Week: 03 Total No.of Contact Hours:39

Types of modeling applicable of power electronics 1

- Types and need for control system 2
- Control system design for converters 3
- To analyze a system and to make use of the information to improve the performance 4
- 5 To analyse a system numerically

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|---|----------------|-----------------------------|
| 1 | Computer Simulation of Power Electronic Converters and Systems: introduction, challenges in computer simulation, simulation process, mechanics of simulation, solution techniques for time-domain analysis, widely used, circuit-oriented simulators, equation solvers. Modelling of Systems: input-output relations, differential equations and linearization, state space representation, transfer function representation, block diagrams, circuit averaging, bond graphs, space vector modelling TEXT 1 and TEXT 2. Reference Book 1 | 10 | L1,L2,L3. |
| 2 | Control System Essentials: control system basics, control principles, state - space method, bode diagram method, root locus method, state space method. TEXT 1 and TEXT 2. Reference Book 1 | 07 | L1,L2,L3. |
| 3 | Digital Controller Design: controller design techniques, PID controller, full state feedback, regulator design by pole placement, estimation design, tracker: controller design, controlling voltage, controlling current, control of induction motor. TEXT 1 and TEXT 2. Reference Book 1 | 07 | L1,L2,L3. |
| 4 | Optimal and Robust Controller Design: least squares principle, quadratic forms, minimum energy principle, least square solution, weighted least squares, recursive least squares, optimal control: linear quadratic, induction motor example, robust controller design. TEXT 1 and TEXT 2. Reference Book 1 | 07 | L1,L2,L3,L4 |
| 5 | Discrete Computation Essentials: numeric formats, tracking the base point in the fixed point system, normalization and scaling, arithmetic algorithms. TEXT 1 and TEXT 2. Reference Book 1 1: Unit 1 to 5 will have internal choice | 08 | L1,L2,L3,L4 |

Unit 1 to 5 will have internal choice Note 1:

Student has to submit one assignment per unit and is evaluated for 10 marks Group Note2: Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project and 5 marks for subject seminar

Out of 5 Units, Unit3is a Webinar unit conducted through Google Note:3 Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty

Course Outcomes:

- CO1 Understand the types of modeling applicable of power electronics
- CO2 Understand the types and need for control systems
- CO3 Design the control system for converters
- CO4 Modelling and simulation of devices along with protection system
- CO5 Verify a system analytically

Course Outcomes Mapping with Programme Outcomes.

| | Course | Level of Blooms | No. of hours of | | | | Pro | grar | nme | Ou | tcon | ne | | |
|-------|--|-----------------|-----------------|---|---|---|-----|------|-----|----|------|----|----|----|
| Sl.No | Outcome | Taxonomy | teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | 2 | 10 | | 3 | 1 | 2 | | | | 2 | | 2 | |
| 2. | CO2. | 2 | 07 | 1 | 3 | 1 | 2 | | | | 2 | | 2 | 3 |
| 3. | CO3: | 4 | 07 | 1 | 3 | 1 | 2 | | | | 2 | | 2 | 3 |
| 4. | CO4: | 4 | 07 | 1 | 3 | 1 | 2 | | | | 2 | | 2 | 3 |
| 5. | CO5: | 4 | 08 | 1 | 3 | 1 | 2 | | | | 2 | | 2 | 3 |
| | Average CO 1 3 1 2 2 2 2 2 3 3 1 2 2 2 3 3 3 1 2 2 2 3 3 3 1 2 2 2 3 3 3 1 2 2 2 3 3 3 3 1 2 2 2 3 | | | | | | | 3 | | | | | | |

Course Outcomes Mapping with Programme Specific Outcomes

| Course Outcome | PSO1 | PSO2 | PSO3 |
|----------------|------|------|------|
| CO1 | | 1 | 2 |
| CO2 | | 2 | 2 |
| C03 | 1 | 2 | 2 |
| CO4 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 2 |
| Average CO | 2 | 2 | 2 |

Text Books.

- 1 Ned Mohan, "Power Electronics Converters, Applications, and Design", Third Edition, Wiley Publisher, 2014
- 2 L. Umanand, "Power Electronics Essentials and Applications", 1stedition, Pearson publisher, 2014

Reference Text Books.

1 M. Godoy Simoes, Felix A. Farret, "Modeling Power Electronics and Interfacing Energy Conversion Systems", 1stedition, Wiley publisher, 2016

Web Links.

- 1 https://vtechworks.lib.vt.edu/handle/10919/31026
- 2 https://ieeexplore.ieee.org/document/931486 Subject Title : EMBEDDED SYSTEMS

Sub.Code:20EPE151

Exam Duration:03 Hrs CIE+Asmt+SS+GA+SEE=30+10+5+5+50=100 Total No.of Contact Hours:39 Course Learning Objectives:

- 1 Describe the functional blocks of a typical embedded system.
- 2 Describe the fundamental issues involved in hardware, software co-designs, embedded hardware and firmware, design and development approaches.
- 3 Embedded system architecture and memory organization.
- 4 The interprocess communication, modeling, devices and communication buses.
- 5 Explain the fundamentals of real time operating systems and latest trends in ES domain and use it to the present need.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|---|----------------|-----------------------------|
| 1 | Introduction to Embedded Systems: embedded systems, processor embedded into a system, embedded hardware units and devices in a system, embedded software in a system, examples of embedded systems, embedded systems – on –chip (soc) and use of VLSI circuit design technology, design process and design examples, Communication Interfaces, classification of embedded systems, skill required for an embedded system designer. -Write a program to toggle all the led to port and with some time delay using ARM7. TEXT 1 and TEXT 2. Reference Book 1 | 07 | L1,L2 |
| 2 | Processor Architecture and Memory Organisation: introduction to advanced architecture, processor and memory organization, performance metrics, memory – types, memory – maps and addresses, processor selection, memory selection, Memory Management of External Memory, Board Memory and performance Basic Steps involved in PCB design. -Write a program to interface 4*4 matrix keypad with ARM7. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 3 | Devices and Communication Buses, Interrupt Services: IO types and examples, serial communication devices, parallel device ports, sophisticated interfacing features in device ports, wireless devices, timer and counting devices, watchdog timer, real time clock Device Drivers and Interrupts Service Mechanisms: Programmed – I/O busy – wait approach without interrupt service mechanism, ISR concept, interrupt sources, interrupt servicing mechanism, direct memory access. | 08 | L1,L2,L3. |

| | -Write a program to verify Timer operation in different | | | | | | | | |
|-------|---|----|-------------|--|--|--|--|--|--|
| | modes | | | | | | | | |
| | | | | | | | | | |
| | TEXT 1 and TEXT 2. Reference Book 3 | | | | | | | | |
| | Program Modeling Concepts: Program models, DFG | | | | | | | | |
| | models, state machine programming models for event - | | | | | | | | |
| | controlled program flow. | | | | | | | | |
| | Interprocess Communication and Synchronization of | | | | | | | | |
| | Processes, Threads and Tasks: multiple processes in an | | | | | | | | |
| 4 | application, multiple threads in an application, tasks, task | 08 | L1,L2,L3,L4 | | | | | | |
| | status, task and data, clear - cut dissention between | | | | | | | | |
| | functions, ISRS and tasks by their characteristics, concept of | | | | | | | | |
| | semaphores. | | | | | | | | |
| | -Write a program to interface Stepper motor with ARM7 | | | | | | | | |
| | TEXT 1 and TEXT 2. Reference Book 1 | | | | | | | | |
| | Real-Time Operating Systems: OS services, process | | | | | | | | |
| | management, timer functions, event functions, memory | | | | | | | | |
| | management, device, file and, real – time operating systems, | | | | | | | | |
| | basic design using an RTOS, RTOS task scheduling models, | | | | | | | | |
| 5 | interrupt latency and response of the task as performance | 08 | L1,L2,L3,L4 | | | | | | |
| | metrics, Task Synchronization, Multiprocessing and | | | | | | | | |
| | Multitasking. OS security issues. | | | | | | | | |
| | - Write a program for interfacing of DC motor with ARM7 | | | | | | | | |
| | TEXT 1 and TEXT 2. Reference Book 2 | | | | | | | | |
| Note | 1: Unit 1 to 5 will have internal choice | | | | | | | | |
| Note? | Note2: Two assignments are evaluated for 10 marks: Assignment -1 Two assignments | | | | | | | | |

are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2

from Units 3, 4 and 5 Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project and 5 marks for subject seminar

Out of 5 Units, Unit 2 is a Webinar unit and will be delivered by subject Note:3 faculty.

Course Outcomes:

- CO1 Understand the concept of embedded system.
- CO2 Analyse the embedded system architecture and memory organization.
- CO3 Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems.
- CO4 Analyse Device Drivers and Interrupts Service Mechanisms
- CO5 Design real time embedded systems using the concepts of RTOS and Analyse various real time applications of embedded system design.

Course Outcomes Mapping with Programme Outcomes.

| G1) I | Course | of | | Trogramme Outcome | | | | | | | | | | | | |
|---------------|---------|--------------------|--|-------------------|----|---|---|---|---|---|---|---|---|---|----|----|
| Sl.No | Outcome | Blooms Taxonomy | | hours teaching | of | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1 | 1 | | 07 | | | 2 | 3 | 2 | 3 | | | 2 | | | |

| 2. | CO2 | 4 | 08 | | 3 | 3 | 3 | 3 | 3 | | 2 | 1 | 2 | 2 |
|-------|------------|---|----|--|---|---|---|---|---|---|---|---|---|---|
| 3. | CO3 | 2 | 08 | | 3 | 3 | 2 | 3 | | | 2 | 1 | 3 | 1 |
| 4. | CO4 | 4 | 08 | | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 3 |
| 5. | CO5 | 5 | 08 | | 3 | 3 | 2 | 3 | 3 | 3 | 2 | | 2 | 2 |
| Avera | Average CO | | | | | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 2 |

Course Outcomes Mapping with Programme Specific Outcomes

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

Text Books.

- 1 Raj Kamal, "Embedded Systems: Architecture, Programming and Design", Second Edition, McGraw Hill, 2014
- 2 Frank Vahid/Tony Givargis, "A Unified Hardware/Software Introduction, Wiley student edition 2002.

Reference Text Books.

- 1 Michael J. Pont, "Embedded C", 2nd Edition, Pearson Education, 2008
- 2 Nigel Gardner, "The Microchip PIC in CCS C", 2nd Revision Edition, Ccs Inc, 2002
- 3 Embedded Software Premier. Simon David, Addison Wessly 2000

Web Links.

- 1 Motorola and Intel Manuals
- 2 www.nptel.com

Subject Title : ADVANCED CONTROL SYSTEMS

| Sub.Code:20EPE152 | No. of Credits: $03=03:0:0 (L - T - P)$ |
|----------------------|---|
| Exam Duration:03 Hrs | CIE+Asmt+GA+SEE=40+5+5+50=100 |

No. of Lecture Hours/Week 03 Total No .of Contact Hours:39

Course Learning Objectives:

- 1 To explain the concepts of basic and digital control system for the real time analysis and design of control systems
- 2 The Modeling of Digital Control Systems.
- 3 To explain and apply concepts of state variables analysis..
- 4 The Optimization of the control parameters using different optimization techniques.
- 5 To study and analyze nonlinear systems.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| 1 | Digital Control: Control System Terminology, Need of Digital control, Configurations of the Basic Digital Control Scheme, Principle of Signal Conversion, Basic Discrete – Time Signals, Time Domain Models for Discrete – Time Systems, The z – Transform, Transfer Function Models, Frequency Response, Stability on the z – Plane and Jury Stability Criterion, Sample and Hold Systems, Sampled Spectra and Aliasing, Reconstruction of Analog Signals, Practical Aspects of the choice of Sampling Rate, Principle of Discretization. TEXT 1 and TEXT 2. Reference Book | 08 | L1,L2,L3,L4 |
| 2 | Models of Digital Control Devices and Systems: Introduction, z–Domain Description of Sampled Continuous – time Plants, z – Domain Description of Samples with Dead – Time, Implementation of Digital Controllers, Tunable PID Controllers, Digital Temperature and Position Control Systems, Stepping Motors and their Control. TEXT 1 and TEXT 2. Reference Book | 08 | L1,L2,L3,L4 |
| 3 | State Variable Analysis of Digital Control Systems: Introduction, State Description of Digital Processors, State Description of Sampled continuous – Time Plants, State Description of Systems with Dead Time, Solution of State Difference Equations, Controllability and Observability, Multivariable Systems. TEXT 1 and TEXT 2. Reference Book | 06 | L1,L2,L3,L4 |
| 4 | Quadratic Optimal Control: Introduction, The Concept of Lyapunov Stability, Lyapunov Functions for Linear Systems, Parameter Optimization and Optimal Control Problems, Quadratic Performance Index, Control Configurations, Optimal State Regulator, Optimal Digital Control Systems, Constrained State Feedback Control. TEXT 1 and TEXT 2. Reference Book | 08 | L1,L2,L3,L4 |

| 5 | Nonlinear System Analysis: Introduction, Common nonlinear System Behaviours, Common nonlinearities in Control Systems, Describing Function Fundamentals, Describing Function of Common nonlinearities, Stability Analysis by the Describing Function Method, Concept of Phase Plane Analysis, Construction of Phase Portraits, System Analysis on the Phase Plane, Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems TEXT 1 and TEXT 2. Reference Book | 09 | L1,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
 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 Analyze the Digital Control Systems.
- CO2 Understand the modelling of Digital Control devices and systems.
- CO3 Understand the fundamentals of state variables, linear and nonlinear systems.
- CO4 Optimize the control parameters using different optimization techniques.
- CO5 Understand and analyse the nonlinear systems

Course Outcomes Mapping with Programme Outcomes.

| Sl.No | Course | Level of Blooms | No. of hours of | Programme Outcome | | | | | | | | | | |
|---------|------------|-----------------|-----------------|-------------------|---|---|---|---|---|---|---|---|----|----|
| 51.100 | Outcome | Taxonomy | teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1:. | 4 | 10 | 3 | 3 | 3 | | 2 | | | 2 | 2 | 2 | |
| 2. | CO2. | 2 | 10 | 3 | 3 | 3 | | 2 | | | 2 | 2 | 2 | |
| 3. | CO3: | 2 | 12 | 3 | 3 | 3 | | 2 | | | 2 | 2 | 2 | |
| 4. | CO4: | 4 | 12 | 3 | 3 | 3 | | 2 | | | 2 | 2 | 2 | |
| 5. | CO5: | 4 | 8 | 3 | 3 | 3 | | 2 | | | 2 | 2 | 2 | |
| Average | Average CO | | | | 3 | 3 | | 2 | | | 2 | 2 | 2 | |

Course Outcomes Mapping with Programme System 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 and State Variable Methods (Conventional and Intelligent Control Systems)", 3rd Edition, McGraw Hill, 2008
- 2 Katsuhiko Ogata, "Modern Control Engineering", 5th Edition, Prentice Hall India, 1997

Reference Text Books.

- 1 Benjamin C Kuo, "Digital Control Systems", 2ndedition, Oxford University Press, 2007
- 2 Katsuhiko Ogata, "State Space Analysis of Control Systems", 5th edition PHI, 1997 Web Links.
- 1 https://www.researchgate.net/publication/331258428_Advanced_Control_Systems_E ngineering_Tutorial_One
- 2 https://nptel.ac.in/courses/108/103/108103007/
- 3 https://www.electronics-tutorial.net/control-systems/
- 4 http://www.ent.mrt.ac.lk/~rohan/teaching/EN5001/Reading/DORFCH1.pdf
- 5 https://ecetutorials.com/control-systems/

Subject Title : PWM CONVERTERS AND APPLICATIONS

Sub.Code:20EPE161 Exam Duration:03 Hrs No. of Credits:03=03:0:0 (L - T – P) CIE+Asmt+SS+GA+SEE=30+10+5+5+50=100 No. of Lecture Hours/Week : 03 Total No.of Contact Hours:39

22

Course Learning Objectives:

- 1 AC/DC and DC/AC Power Conversion
- 2 Different PWM Techniques
- 3 Computation of switching Losses
- 4 Dynamic Modeling of PWM converters
- 5 Different compensation techniques

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| 1 | AC/DC and DC/AC Power Conversion: Overview of applications of voltage source converters. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 2 | PWM Techniques: Pulse modulation techniques for I – phase bridges, bus clamping PWM, space vector based PWM, advanced PWM techniques. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 3 | Loss Calculations: Practical devices in converters, calculation of switching and conduction losses, compensation for dead time and DC voltage regulation. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 4 | Modelling: Dynamic model of PWM converters; constant V/F induction motor drives; estimation of current ripple and torque ripple in inverter fed drives. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3,L4 |
| 5 | Converters with Compensation: Line-side converters with power factor compensation, reactive power compensation, harmonic current compensation TEXT 1 and TEXT 2. Reference Book 1 | 07 | L1,L2,L3 |

Note 1: Unit 1 to 5 will have internal choice

Note2: Student has to submit one assignment per unit and is evaluated for 10 marks. Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project and 5 marks for subject 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 applications of AC/DC and DC/AC Power Conversion

CO2 Analyse different PWM Techniques

CO3 Compute switching and conduction losses

- CO4 Implement dynamic modeling of PWM converters
- CO5 Discuss different compensation techniques

Course Outcomes Mapping with Programme Outcomes.

| | Course | Level of Blooms | No. of hours | | | | Pro | grar | nme | Ou | tcor | ne | | |
|--------|--|-----------------|--------------|---|---|---|-----|------|-----|----|------|----|----|----|
| Sl.No | Outcome | Taxonomy | of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | 2 | 08 | | 2 | 1 | 2 | | | | 2 | | | 2 |
| 2. | CO2. | 2 | 08 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| 3. | CO3: | 2 | 08 | 3 | 2 | 1 | 2 | | | | 2 | | 2 | |
| 4. | CO4: | 3 | 08 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| 5. | CO5: | 2 | 07 | 3 | 3 | 1 | 2 | | | | 2 | 2 | 2 | |
| Averag | Average CO 3 3 1 2 1 2 2 1 2 2 | | | | | | | | 2 | | | | | |

Course Outcomes Mapping with Programme Specific Outcomes

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

Text Books.

- 1 Mohan, Undeland and Robbins, "Power Electronics: Converter, Applications and Design", Third Edition, Wiley Publisher, 2011
- 2 Erickson RW, "Fundamentals of Power Electronics", 1st edition, Chapman Hall, 1997

Reference Text Books.

1 Joseph Vithyathil, "Power Electronics- Principles and Applications", 1st edition, TMH, 2011

Web Links.

- 1 https://onlinelibrary.wiley.com/doi/book/10.1002/9781118886953
- 2 <u>https://books.google.co.in/books/about/Power_Electronic_Converters.html?id=5vTtWUOn</u> <u>60AC&redir_esc=y</u>

Subject Title : MPPT IN SOLAR SYSTEMS

| Sub.Code:20EPE162 | No. of Credits: $03=03:0:0 (L - T - P)$ | No. of Lecture Hours/Week : 03 |
|----------------------|---|--------------------------------|
| Exam Duration:03 Hrs | CIE+Asmt+SS+GA+SEE=30+10+5+5+50=100 | Total No.of Contact Hours:39 |

Course Learning Objectives:

- 1 To explain the PV cell, its characteristics and its models, equivalent circuits and circuit parameter calculations.
- 2 To explain different methods of tracking maximum power point and effect of noise on MPPT and reduction of noise
- 3 To explain distributed Maximum Power Point Tracking of PV arrays and its DC analysis
- 4 To explain distributed Maximum Power Point Tracking of PV arrays and its AC analysis
- 5 To explain the design of high energy efficiency power converters for PV MPPT.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|---|----------------|-----------------------------|
| 1 | PV Modelling: From the Photovoltaic Cell to the Field, The Electrical Characteristic of a PV Module, The Double-Diode and Single-Diode Models, From Data Sheet Values to Model Parameters, Example: PV Module Equivalent Circuit Parameters Calculation, The Lambert W Function for Modelling a PV Field, Example. Maximum Power Point Tracking: The Dynamic Optimization Problem, Fractional Open-Circuit Voltage and Short-Circuit Current, Soft Computing Methods, The Perturb and Observe Approach TEXT 1 and TEXT 2. Reference Book1 | 08 | L1,L2,L3. |
| 2 | Maximum Power Point Tracking (continued): Improvements of the P&O Algorithm, Evolution of the Perturbative Method, PV MPPT via Output Parameters, MPPT Efficiency. MPPT Efficiency: Noise Sources and Methods for Reducing their Effects: Low-Frequency Disturbances in Single-Phase Applications, Instability of the Current-Based MPPT Algorithms, Sliding Mode in PV System, Analysis of the MPPT Performances in a Noisy Environment, Numerical Example. TEXT 1 and TEXT 2. Reference Book1 | 08 | L1,L2,L3. |
| 3 | Distributed Maximum Power Point Tracking of Photovoltaic Arrays: Limitations of Standard MPPT, A New Approach: Distributed MPPT, DC Analysis of a PV Array with DMPPT, Optimal Operating Range of the DC Inverter Input Voltage. TEXT 1 and TEXT 2. Reference Book1 | 08 | L1,L2,L3. |
| 4 | Distributed Maximum Power Point Tracking of Photovoltaic Arrays (continued): AC Analysis of a PV Array with DMPPT TEXT 1 and TEXT 2. Reference Book1 | 07 | L1,L2,L3. |
| 5 | Design of High-Energy-Efficiency Power Converters for PV MPPT Applications: Introduction, Power, Energy, Efficiency, EnergyHarvesting in PV Plant Using DMPPT Power Converters, Losses in Power Converters, Losses in the Synchronous FET Switching Cells, Conduction Losses, Switching Losses TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |

Note 1: Unit 1 to 5 will have internal choice

- Note2: Student has to submit one assignment per unit and is evaluated for 10 marks and Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project and 5 marks for subject 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 Understand the characteristics of a PV cell and its models, equivalent circuits and circuit parameter calculations.
- CO2 Understand the different methods of tracking maximum power point and distributed MPPT.
- CO3 Identify the sources of noise, effect of noise on MPPT and reduction of noise
- CO4 Analyse the differences between AC and DC analysis of PV array with DMPPT
- CO5 Understand the use of high energy efficiency power converters for PV MPPT application.

Course Outcomes Mapping with Programme Outcomes.

| | Course | Level of Blooms | No. of hours | | | | Pro | grar | nme | Ou | tcor | ne | | |
|--------|---------|-----------------|--------------|---|---|---|-----|------|-----|----|------|----|----|----|
| Sl.No | Outcome | Taxonomy | of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | 2 | 08 | | 1 | 1 | 2 | | | | 1 | | 1 | |
| 2. | CO2. | 2 | 08 | 2 | 2 | 1 | 3 | | | | 2 | | 2 | 2 |
| 3. | CO3: | 3 | 08 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | |
| 4. | CO4: | 4 | 07 | 1 | 2 | 1 | 2 | | | | 2 | | 2 | 2 |
| 5. | CO5: | 3 | 08 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | |
| Averag | ge CO | | | 2 | 2 | 1 | 2 | | | | 2 | | 2 | 1 |

Course Outcomes Mapping with Programme Specific Outcomes

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

Text Books.

- 1 Nicola Femia et al, "Power electronics and Control Techniques for Maximum energy harvesting in Photovoltaic systems", first Edition, IEEE press and John Wiley & Sons CRC Press, 2013
- 2 Kamal Kant Sharma, Satya Nand Vishwakarma, Gaziz Manzoor, "Hybrid PSD-GSA Based MPPT Algorithm for Photovoltaic System Understanding FACTS: Concepts and

Technology of Flexible AC Transmission Systems", 1st edition, Published by Independently , 2019

Reference Text Books.

1 Kamal Kant Sharma, "Hyrid PSD-GSA Based MPPT Algorithm for Photovoltaic Systems", 1st edition, Published by Independently, 2015

Web Links.

- ¹ https://www.intechopen.com/books/recent-developments-in-photovoltaic-materials-anddevices/improved-performance-of-a-photovoltaic-panel-by-mppt-algorithms
- ² https://www.researchgate.net/publication/317723124_Designing_and_implementation_of_ maximum_power_point_trackingMPPT_solar_charge_controller

Subject Title : ELECTRIC VEHICLE TECHNOLOGY

| Sub.Code:20EPE163 | No. of Credits: $03=03:0:0 (L - T - P)$ | No. of Lecture Hours/Week : 03 |
|--------------------------|---|--------------------------------|
| Exam Duration:03 Hrs | CIE+Asmt+SS+GA+SEE=30+10+05+05+50=100 | Total No.of Contact Hours:39 |
| Course Learning Objectiv | es: | |

- 1 Advantages of EVs.
- 2 Various drive trains
- 3 Characteristics of various types of batteries.
- 4 Concept of hybrid electric vehicles
- 5 Emerging technology of EV's

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| 1 | Introduction to electric vehicles (EVs): EV advantages and impacts. EV regulations and standardization. Electric vehicle (EV) design options: EV con figurations: fixed vs. variable gearing, single- vs. multiple-motor drive, in-wheel drives. EV parameters, driving cycles and performance specifications. Choice of system voltage levels: electrical safety and protection. TEXT 1 and TEXT 2. Reference 1 | 8 | L1,L2, L3,L4 |
| 2 | Vehicle dynamics and motor drives: Road load: vehicle kinetics; effect of velocity, acceleration and grade. EV drive train and components. EV motor drive systems: DC drives, induction motor drives, switched reluctance motor drives, control strategies. TEXT 1 and TEXT 2. Reference 1 | 8 | L1,L2,L3,L4 |
| 3 | Batteries: Battery parameters, types and characteristics of EV batteries. Charging schemes. Open-circuit voltage and ampere- hour estimation. Battery load levelling TEXT 1 and TEXT 2. Reference 1 | 8 | L1,L2,L3 |
| 4 | Emerging EV technologies: Hybrid electric vehicles (HEVs): types, operating modes, torque coordination and control, generator/motor requirements. TEXT 1 and TEXT 2. Reference 1 | 9 | L1,L2,L3 |
| 5 | Fuel cell electric vehicles (FEVs): Fuel cell characteristics, hydrogen storage systems, ultra- capacitors. TEXT 1 and TEXT 2. Reference 1 | 6 | L2,L3,L4 |
| Note | 1 : Unit 1 to 5 will have internal choice | | |

Student has to submit one assignment per unit and is evaluated for 10 marks and Note2: group activity for 5 marks and Seminar for 5 Marks

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

Course Outcomes:

- CO1 Describe the configuration of a typical electric vehicle
- CO2 Differentiate among different drive trains
- CO3 Understand the limitations and advantages of various battery chemistries.
- CO4 Develop strategies for charging various types of batteries.
- CO5 Describe the various drive trains of hybrid electric vehicles.

Course Outcomes Mapping with Programme Outcomes.

| S1.No | Course | Level of Blooms | No. of hours | | | | Pro | grar | nme | Ou | tcor | ne | | |
|--------|---------|-----------------|--------------|---|---|---|-----|------|-----|----|------|----|----|----|
| 51.140 | Outcome | Taxonomy | of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | L1,L2 | 8 | 1 | 3 | 1 | | | | | | | | |
| 2. | CO2. | L1,L2 | 8 | 1 | 3 | 1 | | | | | | | | |
| 3. | CO3: | L1,L2 | 8 | 3 | 1 | 1 | | | | | | | | |
| 4. | CO4: | L2,L3 | 9 | | 3 | 1 | 1 | | | | | | | |
| 5. | CO5: | L2,L3 | 6 | 1 | 3 | 1 | | | | | | | | |
| | | Average CO | | 2 | 3 | 1 | 1 | | | | | | | |

Course Outcomes Mapping with Programme Specific Outcomes

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

Text Books.

- 1 C.C. Chan and K.T. Chau**"Modern Electric Vehicle Technology"**,1st edition Oxford University Press, London, 2001
- 2 Iqbal Husain "Electric and Hybrid Vehicles"1stedition New York: CRC Press, 2016.

Reference Text Books.

 M. Ehsani, Y. Gao, S.E. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design, 1st edition New York: CRC Press, 2004

Web Links.

1. Prof. Amit Jain"Electrical Vehicle part 1" http://nptel.ac.in/courses

Subject Title : POWER ELECTRONICS LABORATORY-I

Sub.Code:**20EPEL17** Exam Duration:3 Hrs No. of Credits:2=0:0:2(L - T - P) CIE +SEE=50+50=100 No. of Lecture Hours/Week :03 Total No.of Contact Hours:30

Course Learning Objectives:

- 1 To conduct experiments on various converters and devices.
- 2 To analyse various parameters of converters.
- 3 To compute the performance of various converters.
- 4 To understand the working of controlled converters.
- 5 To compare dynamic characteristics of switching devices.

| Expt .No | Experiments | No.of Hours | Blooms Taxnomy level. |
|-------------|--|----------------|-----------------------------|
| 1 | Analysis of static and dynamic characteristic of MOSFET and IGBT | 3 | L2,L4 |
| 2 | Performance of single phase fully controlled and semi-controlled converter for RL load for continuous current mode. | 3 | L1,L2,L3. |
| 3 | Performance of single phase fully controlled and semi-controlled converter for RL load for discontinuous current mode. | 3 | L1, L2, L3 |
| 4 | Study of effect of source inductance on the performance of single phase fully controlled converter. | 3 | L1, L2, L3 |
| 5 | Performance analysis of three phase fully controlled and semi- controlled converter for RL load for continuous current mode. | 3 | L2, L3, L4 |
| 6 | Performance analysis of three phase fully controlled and semi- controlled converter for RL load for discontinuous current mode. | 3 | L2, L3, L4 |
| 7. | Performance analysis of single phase bridge inverter for RL load and voltage control by single pulse width modulation. | 3 | L2, L3, L4 |
| 8. | Performance analysis of two quadrant chopper. | 3 | L2, L3, L4 |
| 9 | Diode clamped multilevel inverter. | 3 | L1, L2, L3 |
| 10 | ZVS operation of a synchronous buck converter. | 3 | L1, L2, L3 |
| 11 | *Simulation of converters using NgSpice open source. | | |

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only. * Experiment is for additional skill not for exam.

Course Outcomes:

- CO1 To conduct experiments on various converters and devices.
- CO2 To compare dynamic characteristics of switching devices.
- CO3 To compute the performance of various converter.
- CO4 To understand the working of controlled converters.
- CO5 To analyse various parameters of converters.

Course outcomes Mapping with programme outcomes

| S1 No | Course | Level of Blooms | No. of hours of | | | | Pro | grar | nme | e Ou | tcon | ne | | |
|-------|---------|-----------------|-----------------|---|---|---|-----|------|-----|------|------|----|----|----|
| Sl.No | Outcome | Taxonomy | teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | L1,L2 | 06 | 3 | | 1 | | | 1 | | | | | 1 |
| 2. | CO2: | L2,L3 | 06 | | 3 | 1 | | | 1 | | | | | 1 |
| 3. | CO3: | L2,L3 | 06 | | | 3 | | | 1 | | | | | 1 |
| 4. | CO4: | L1,L2 | 06 | 3 | 1 | | | | | | | | | |
| 5. | CO5: | L2,L4 | 06 | 1 | 3 | | | | | | | | | |
| | | | Average CO | 2 | 3 | 2 | | | 1 | | | | | 1 |

Course Outcomes Mapping with Programme Specific Outcomes

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

References Text Books.

- 1 Ned Mohan, Tore M. Undeland, William P. Robbins"**Power Electronics Converters, Applications, and Design**", Third Edition, Wiley India Pvt. Ltd, 2011
- 2 Rashid M.H, "Power Electronics Circuits Devices and Applications", 3rd Edition, Pearson, 2011.

D K Bose"Modern Power Electronics & AC Drives", 1st edition, 2012

Web Links.

1 B. G. Fernandes" A course on Power Electronics" http://nptel.ac.in/courses/108101038/

2. K. Gopakumar "A course on Industrial Drives – Power Electronics" <u>http://nptel.ac.in/courses/108108077</u>

| Sub.Code: 20EPE21 | No. of Credits: $03=03:0:0 (L - T - P)$ |
|----------------------|---|
| Exam Duration:03 Hrs | CIE+Asmt+SS+GA+SEE=30+10+5+5+50=100 |

Course Learning Objectives:

- 1 Different Quadrant operation of Drives..
- 2 The concept of DC variable speed drives.
- 3 Different control methods of AC drives.
- 4 Closed loop Control of AC Drives
- 5 Control Techniques using Microprocessor/Microcontroller

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| 1 | Electric Drives: Introduction – block diagram-classification of electrical drivesfundamental torque equation- components of load torque- steady state stability. TEXT 1 and TEXT 2. Reference Book 1 | 8 | L1,L2,L3. |
| 2 | DC Drives: Two quadrants Drive: 1-phase and 3-phase full converter drive. Four Quadrant drive: Three- phase dual converter drive. Different braking methods and closed loop control of DC drives. TEXT 1 and TEXT 2. Reference Book 2 | 8 | L1,L2,L3. |
| 3 | AC Drives: Voltage and current source inverter - inverter control-six step and PWM operation, Control of Induction motor drive -V/f and field oriented control – direct and indirect vector control, voltage and current source inverter fed induction motor drives, stator and rotor voltage control methods, slip energy recovery drives. TEXT 1 and TEXT 2. Reference Book 1 | 8 | L1,L2,L3. |
| 4 | Closed Loop Control of AC Drives: Basic Principle of Vector Control, Direct & Indirect Vector control of Induction Motor, Stator voltage control, Slip regulation and Speed control of static Kramer's drive. TEXT 1 and TEXT 2. Reference Book 3 | 8 | L1,L2,L3. |
| 5 | Microcontroller Control of Electric Drives: Introduction to Microcontroller, Timers, Interrupts, ADC and DAC, Control of DC drives using microcontroller, Microcontroller based regular sampled PWM control using three timer control and four timer control. Control of VSI- Induction motor drives using Microcontroller. TEXT 3 Reference Book 2 | 7 | L1,L2,L3. |
| Note 1 | | L | <u> </u> |

Note2: Student has to submit one assignment per unit and is evaluated for 10 marks and group activity for 5 marks and Seminar for 5 Marks

Note:3Out 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 Acquainted with the knowledge of various AC/DC drives
- CO2 Demonstrate the knowledge of different quadrant operation of AC/DC drives.
- CO3 Demonstrate the different methods of AC drives control.
- CO4 Develop the closed loop control of Electrical Drives.

CO5 Acquainted the knowledge of using microprocessor for Drive control.

Course Outcomes Mapping with Programme Outcomes.

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

Text Books.

- 1 B K Bose, "Modern Power Electronics & AC Drives", 2nd edition, PHI, 2011
- 2 R Krishnan, "Electric Motor Drives", 2nd edition, PHI, 2010
- 3 IEEE Transactions on Industry Applications, "Simple Microprocessor Implementation of New Regular Sampled Harmonic Elimination PWM Techniques,", Vol 28, No.1, Jan/Feb 1992, pp.89-94

Reference Text Books.

- 1 Murphy JMD, Turnbull F.G., "Thyristor Control of AC Motors", Third edition, Pergamon Press Oxford, 1998, Choose an item.
- 2 MehrdadEhsani, YiminGaoAlinEmadi, "High Performance Control of AC Drives, Wiley 2012
- 3 Muhammad H. Rashid, "Power Electronics- Circuits, Devices and Applications, Pearson Prentice Hall, 2010.

Web Links.

- 1 https://www.academia.edu/26714897/R_Krishnan_Electric_Motor_Drives_Modeling_Analysis_and_Control_2001_
- ² https://www.pdfdrive.com/modern-power-electronics-and-ac-drives-e18928858.html
- ³ file:///C:/Users/EEE/Downloads/32_Sample_Chapter.pdf

Subject Title : SWITCHED MODE POWER CONVERSION

 Sub.Code:20EPE22
 No. of Credits:03=03:0:0 (L - T - P)

 Exam Duration:03 Hrs
 CIE+Asmt+SS+GA+SEE=30+10+05+05+50=100

No. of Lecture Hours/Week : 03 Total No.of Contact Hours:39

Course Learning Objectives:

- 1 To explain operating principle of various converters.
- 2 To design transformer and inductor for Dc-DC converter
- 3 To analyze and distinguish different power converters
- 4 To design different power converters.
- 5 To solve problems on different power converters.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| 1 | DC – DC Converters (Basic Converters): Linear voltage regulators (LVRs), a basic switching converter(SMPC), comparison between LVR & SMPC, principle of operation and analysis of buck converter analysis, inductor current ripple and output voltage ripple, capacitor resistance effect, synchronous rectification, design considerations, buck converter for discontinuous current operation, principle of operation and analysis of boost converter, inductor current ripple and output voltage ripple, inductor resistance effect, design considerations, boost converter for discontinuous current operation, principle of operation and analysis of boost converter, inductor current ripple and output voltage ripple, inductor resistance effect, design considerations, boost converter for discontinuous current operation and analysis of buck boost converter analysis, inductors current ripple and output voltage ripple, design considerations for continuous current mode operation.Buck-boost converter for discontinuous current operation. TEXT 1 and Text 2 Reference 1 | 8 | L1,L2, L3,L4 |
| 2 | Principle of operation and analysis of CUK converter, inductor current ripple and output voltage ripple, capacitor resistance effect, design considerations, single ended primary inductance converter(SEPIC). Derived Converters: Introduction, transformer models, principle of operation and analysis of fly back converter-continuous and discontinuous current mode of operation, design considerations, principle of operation and analysis of forward converter, design considerations. TEXT 1 and Text 2 Reference 1 | 7 | L2,L3,L4 |
| 3 | Principle of operation and analysis of push-pull converter, design considerations, principle of operation and analysis of full bridge and half- bridge DC-DC converters, design considerations, current fed converters, multiple outputs. TEXT 1 and TEXT 2. | 8 | L2,L3,L4 |
| 4 | Control of DC-DC Converter: Modeling of DC-DC converters, power supply control, control loop stability, small signal analysis, switch transfer function, filter transfer function, PWM transfer function, Type-2 error amplifier with compensation, Type-3 error amplifier with compensation, design. TEXT 1 and TEXT 2. Reference Book 3 | 8 | L2,L3,L4 |

| Resonant Converters: Introduction, resonant switch ZCS converter, principle of operation and analysis, resonant switch ZVS converter, principle of operation and analysis, series resonant inverter, series resonant DC-DC converter, parallel resonant DC-DC converter, series- parallel L2,L3,L4,L5 resonant DC-DC converter, resonant converters comparison. Design of inductor and transformers for SMPC. TEXT 1 and TEXT 2. Reference 2 | Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|--|------------|---|----------------|-----------------------------|
| | 5 | principle of operation and analysis, resonant switch ZVS converter, principle of operation and analysis, series resonant inverter, series resonant DC-DC converter, parallel resonant DC-DC converter, series- parallel resonant DC-DC converter, resonant converters comparison. Design of inductor and transformers for SMPC. | 8 | L2,L3,L4,L5 |

Note 1: Unit 1 to 5 will have internal choice

Note2: Student has to submit one assignment per unit and is evaluated for 10 marks and group activity for 5 marks and Seminar for 5 Marks

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 Explain operating principle of various converters.
- CO2 Design transformer and inductor for Dc-DC converter.
- CO3 Analyze and distinguish different power converters.
- CO4 Design different power converters.
- CO5 Solve problems on different power converters.

Course Outcomes Mapping with Programme Outcomes.

| | Course | Level of | No. of hours | Programme Outcome | | | | | | | | | | |
|-------|------------|--------------------|--------------|-------------------|---|---|---|---|---|---|---|---|----|----|
| S1.No | Outcome | Blooms Taxonomy | of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1 | L1, L2 | 8 | 3 | 1 | 1 | | | | | | | | |
| 2. | CO2 | L2, L4 | 7 | | 1 | 3 | | | | | | | | |
| 3. | CO3 | L2,L4 | 8 | | 3 | 1 | 1 | | | | | | | |
| 4. | CO4 | L2,L4 | 8 | | 1 | 3 | 1 | | | | | | | |
| 5. | CO5 | L2,L3 | 8 | | 1 | 3 | | | | | | | | |
| | Average CO | | | | | 3 | 1 | | | | | | | |

Course Outcomes Mapping with Programme Specific Outcomes

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

Text Books.

- 1 Daniel W Hart "Power Electronics", First Edition, Tata McGraw Hill, 2011
- 2 Rashid M.H, "Power Electronics Circuits Devices and Applications", 3rd Edition, Pearson, 2011.

Reference Text Books.

- 1 D M Mitchel "DC-DC Switching Regulator Analysis -", 1st edition, McGraw-Hill Ltd. 1988
- 2 Umanand L and Bhatt S R, "Design of Magnetic Components for Switched Mode Power Converters", 1 st edition, New Age International 2001
- 3 Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd edition, Wiley India Pvt. Ltd2010

Web Links.

- ¹ Prof. B. G. Fernandes" A course on Power Electronics" <u>http://nptel.ac.in/courses/108101038/</u>
- Prof. V. Ramnarayan/Prof. L. Umanand "A course on Switched Mode Power Conversion") <u>http://nptel.ac.in/courses/1081080363</u> Prof. K. Gopakumar "A course on Industrial Drives – Power Electronics"

Subject Title : POWER ELECTRONICS SYSTEM DESIGN USING LINEAR ICs

Sub.Code:20EPE23

No. of Credits:03=03:0:0 (L - T - P)

No. of Lecture Hours/Week : 03

Exam Duration:03 Hrs

CIE+Asmt+SS+GA+SEE=30+10+05+05+50=100

Total No.of Contact Hours:39

Course Learning Objectives:

- 1 Understand basic requirements of designing, measurement & protection circuits for power electronics systems using ICs.
- 2 Analyze various PWM ICs for controlling power electronics systems.
- 3 To analyze and distinguish different A/D and D/A converter circuits using ICs.
- 4 To design different power converters gating circuits using ICs.
- 5 To understand and program using PLC for power converters control.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. | | | | |
|------------|---|----------------|-----------------------------|--|--|--|--|
| 1 | Introduction: Measurement techniques for voltages, current, power, power factor in power electronic circuits, sensing of speed. TEXT 1 and Text 2 | 7 | L1,L2 | | | | |
| 2 | Switching Regulator Control Circuits: Introduction, isolation techniques of switching regulator systems, PWM systems. TEXT 1 and Text 2 | 7 | L2,L3 | | | | |
| 3 | Commercial PWM Control ICs and their Applications: TL 494 PWM control IC, UC 1840 programmable off line PWM controller, UC 1860 resonant mode power supply controller. Switching power supply ancillary, supervisory & peripheral circuits and components: introduction, opto couplers, self-biased techniques used in primary side of reference power supplies, soft/start in switching power supplies. TEXT 1 and TEXT 2.Reference Book 2 | 9 | L3,L4 | | | | |
| 4 | Protection of Switching power supply systems: current limit circuits, over voltage protection, AC line loss detection. Phase – Locked Loops (PLL) & Applications: PLL Design using IC:, 555 timer & its applications, analog to digital converter using IC's, digital to analog converters using ICs, implementation of different gating circuits. TEXT 1 and TEXT 2. Reference Book 3 | 8 | L2,L3,L4 | | | | |
| 5 | Programmable Logic Controllers (PLC): Basic configuration of a PLC, power converter control using PLC,IC for Switch-Mode Power Supplies: Control IC for Switch mode power supplies, IC timers as controllers for switch-mode power supplies. TEXT 1 and TEXT 2. Reference 2 | 8 | L2,L3,L4 | | | | |
| Note | Note 1: Unit 1 to 5 will have internal choice | | | | | | |
| Noto | Nota? • Student has to submit one assignment per unit and is evaluated for 10 marks and | | | | | | |

Note2: Student has to submit one assignment per unit and is evaluated for 10 marks and group activity for 5 marks and Seminar for 5 Marks

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

Course Outcomes:

CO1 Identify different measuring instruments required in Power Electronics circuits.

- CO2 Explain different methods of protection & isolation required in Power Electronics circuits.
- CO3 Justify different ICs available for PWM generation in Power converters.
- CO4 Understand PLC programming & implement gating circuits for power converters.

CO5 Analyse different switching power supply protection circuit.

Course Outcomes Mapping with Programme Outcomes.

| | | Lev | No. | | | | | Progra | umme (| Dutcon | ne | | | |
|-----------|---------------------------|--|---|---|---|---|---|--------|--------|--------|----|---|----|----|
| Sl. No | Cour se Outc ome | el of Blo oms Tax ono my | of hou rs of tea chi ng | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1 | 2 | 7 | | 3 | 1 | 2 | | | | 2 | | 2 | |
| 2. | CO2 | 2 | 7 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| 3. | CO3 | 2 | 9 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| 4. | CO4 | 4 | 8 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| 5. | CO5 | 5 | 8 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | |
| | Averag | ge Cos | | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |

Course Outcomes Mapping with Programme Outcomes.

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

Text Books.

- 1 G. K. Dubey, S. R. Doradla, A. Joshi, and R. M. K. Sinha, Thyristorised Power Controllers, 2nd Edition, New Age International, 2010.
- 2 Ned Mohan, Tore M. Undeland, William P. Robbins ,"Power Electronics Converters, Applications, and Design ", 3rd Edition, Wiley India Pvt. Ltd ,2010 .

Reference Text Books.

- 1 Unitrode application notes: http://www.smps.us/Unitrode.html
- 2 Switch- Mode Power Supply Design, P.R.K. Chetty, BPB Publications
- 3 Chryssis,, "High Frequency Switching Power Supplies", 2nd edition, MGH1989

Web Links.

- 1 Prof. L Umanand , Design and Simulation of Power conversion using open source tools, | IISc Bangalore
- 2 Prof. L Umanand, PV module in SPICE Videos | View ENGGtalks, IISc Bangalore
- 3 Abhijt Kshirsagar, Simulation toolkit using gEDA and ngSPICE for Digital Controller Design Course, IIT, Dharwad

Subject Title : HVDC POWER TRANSMISSION

| Sub.Code:20EPE24 | No. of Credits: $03=03:0:0 (L - T - P)$ | No. of Lecture Hours/Week : 03 |
|----------------------|---|--------------------------------|
| Exam Duration:03 Hrs | CIE+Asmt+SS+GA+SEE=30+10+05+05+50=100 | Total No.of Contact Hours:39 |

Course Learning Objectives:

- 1 To give an introduction to DC power transmission and describe the basic components of a converter.
- 2 To describe the methods for compensating the reactive power demanded by the converter and the methods for simulation of HVDC systems
- 3 To describe the types of filters for removing harmonics and the characteristics of the system impedance resulting from AC filter designs and different methods of control of HVDC converter and system.
- 4 To explain the design techniques for the main components of an HVDC system.
- 5 To explain the protection of HVDC system and other converter configurations used for the HVDC transmission and the recent trends for HVDC applications.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|---|----------------|-----------------------------|
| 1 | 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. TEXT 1 and Text 2 | 8 | L2, L3,L4 |
| 2 | Harmonics of HVDC and Removal: Introduction, Determination of Resulting Harmonic Impedance, Active Power Filter. Control of HVDC Converter and System: Converter Control for an HVDC System, Commutation Failure TEXT 1 and Text 2 | 8 | L2,L3,L4 |
| 3 | Control of HVDC Converter and System (continued): HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability. Interactions between AC and DC Systems: Definition of Short Circuit Ratio and Effective Short Circuit Ratio. | 8 | L2,L3 |
| 4 | Main Circuit Design: Converter Circuit and Components, Converter Transformer, Cooling System, HVDC Overhead Line, HVDC Earth Electrodes, HVDC Cable, HVDC Telecommunications Current Sensors, HVDC Noise and Vibration. TEXT 1 and TEXT 2. Reference Book 3 | 8 | L2,L3 |
| 5 | Fault Behaviour and Protection of HVDC System: Valve Protection Functions, Protective Action of an HVDC System, Protection by Control Actions, Fault Analysis. Other Converter Configurations for HVDC Transmission: Introduction, Voltage Source Converter (VSC), CCC and CSCC HVDC System, 10.4 Multi-Terminal DC Transmission. | 7 | L2,L3,L4 |

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. | | | |
|------------|--|----------------|-----------------------------|--|--|--|
| | Trends for HVDC Applications: Wind Farm Technology, Modern Voltage | | | | | |
| | Source Converter (VSC) HVDC Systems. | | | | | |
| | TEXT 1 and TEXT 2. Reference 3 | | | | | |
| | Unit 1 to 5 will have internal choice | | | | | |

Note 1:

Unit 1 to 5 will have internal choice

- Note2: Student has to submit one assignment per unit and is evaluated for 10 marks and group activity for 5 marks and Seminar for 5 Marks
- Out of 5 Units, Unit1is a Webinar unit conducted through Google Classroom/Zoom/Cisco Note:3 Webex etc and will be delivered by subject faculty.

Course Outcomes:

- CO1 Explain the importance of DC power transmission, the basic components of a converter and methods for compensating the reactive power.
- CO2 Explain the methods for simulation of HVDC systems and its control.
- CO3 Design filters for eliminating harmonics.
- CO4 Explain the design techniques for the main components of an HVDC system.
- CO5 Analyse the protection of HVDC system and other converter configurations used for the HVDC transmission and recent trends for HVDC applications.

Course Outcomes Mapping with Programme Outcomes.

| S1.No | Course Level of Blooms | No. of hours | Programme Outcome | | | | | | | | | | | |
|-------|------------------------|--------------|-------------------|---|---|---|---|---|---|---|---|---|----|----|
| | Outcome | Taxonomy | of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | L1,L2 | 8 | | 3 | 1 | 2 | | | | 2 | | 2 | |
| 2. | CO2 | L1,L2 | 8 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | |
| 3. | CO3 | L2,L3 | 8 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | |
| 4. | CO4 | L1,L2 | 8 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | |
| 5. | CO5 | L3,L4 | 7 | 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 | 3 | | |
| CO2 | 3 | | |
| CO3 | 2 | 2 | |
| CO4 | 3 | | |
| C05 | 2 | 2 | |
| Average CO | 3 | 2 | |

Text Books.

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

Reference Text Books.

- 1 K. R. Padiyar, "HVDC Power Transmission Systems", New Age International, 2012.
- 2 E.W.Kimbark "Direct Current Transmission", Vol.1, Wiley Inter-Science, London, 2006
- 3 Arrilaga, "High Voltage Direct Current Transmission", the Institute of Engineering and Technology, 2ndEdition, 2007.

Vijay K Sood, "HVDC and FACTs Controllers; Applications of Static Converters in Power Systems, BSP Books Pvt. Ltd., First Indian reprint 2013.

Web Links.

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

Subject Title : DSP APPLICATIONS TO DRIVES

| Sub.Code: 20EPE263 | No. of Credits: $03=03:0:0 (L - T - P)$ | No. of Lecture Hours/Week : 03 |
|----------------------|---|--------------------------------|
| Exam Duration:03 Hrs | CIE+Asmt+SS+GA+SEE=30+10+5+5+50=100 | Total No.of Contact Hours:39 |

Course Learning Objectives:

- 1 DSP controller, CPU architecture and instruction set
- 2 DSP-Based Applications
- 3 DSP-based control of permanent magnet brushless DC machines.
- 4 DSP-based vector control of permanent magnet synchronous motors.
- 5 DSP-based vector control of Induction motors.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| 1 | Introduction: To the TMS320LF2407 DSP Controller, DSP CPU architecture and instruction set. General Purpose Input/output (GPIO) functionality interrupts on the TMS320LF2407. Programming using Mat Lab. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 2 | Analog-to-Digital Converter (ADC), event managers (EVA, EVB). DSP-Based Applications: Of DC-DC buck-boost converters, DSP based control of stepper motors. TEXT 1 and TEXT 2. Reference Book 2 | 08 | L1,L2,L3. |
| 3 | DSP-Based control of permanent magnet brushless DC machines, Park and Clarke transformations. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 4 | Space Vector Pulse Width Modulation, DSP-based control of permanent magnet synchronous machines. TEXT 1 and TEXT 2. Reference Book 2 | 08 | L1,L2,L3. |
| 5 | DSP-based vector control of induction motors TEXT 1 and TEXT 2. Reference Book 2 | 07 | L1,L2,L3. |

Note 1: Unit 1 to 5 will have internal choice

Note2: Student has to submit one assignment per unit and is evaluated for 10 marks and group activity for 5 marks and Seminar for 5 Marks

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

Course Outcomes:

- CO1 Explain DSP controller, CPU architecture and to write instruction set for specific task.
- CO2 Implement DSP for specific Applications.

CO3 Apply the transformation for machine modelling

- CO4 Implement DSP-based vector control of permanent magnet synchronous machine.
- CO5 Implement DSP-based vector control of induction motors.

Course Outcomes Mapping with Programme Outcomes.

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

Text Books.

- 1 Hamid Toliyat and Steven Campbell, "DSP-Based Electromechanical Motion Control CRC press", 2011
- 2 P.C.Krause, Oleg Wasynczuk, Scott D. Sudhoff, , "Analysis of Electrical Machinery and Drive Systems ", 2nd edition, Wiley India, 2010
- 3 Chee-Mun Ong , "Dynamic Simulation of Electric Machinery using Matlab / Simulink ", Prentice Hall, 1998

Reference Text Books.

- 1 Hugo Guzman, Mario Bermudez, Cristina Martin, Federic Barrero and Mario Duran, Intechopen.com, , "Application of DSP inPower Conversion Systems—A Practical Approach for Multiphase Drives 2015".
- 2 A Nagoor Kani, "Digital Signal Processing, 2 edition, McGraw Hill, 2013.

- 1 https://www.researchgate.net/publication/261235058_DSP_implementation_of_electric_drive_control_syste m
- 2 https://www.intechopen.com/books/applications-of-digital-signal-processing-through-practicalapproach/application-of-dsp-in-power-conversion-systems-a-practical-approach-for-multiphase-drives
- 3 https://www.analog.com/en/analog-dialogue/articles/dsp-based-control-for-ac-machines.html

Panchajanya Vidya Peetha Welfare Trust (Regd)



Dr. Ambedkar Institute of Technology

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Ref. No.

Date : 05.01.2023

2020-21

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

| Sl | Subject Code | Subject title | Mapped to |
|-----|--------------|--|----------------------------------|
| No | | | Employability/Entrepreneur/Skill |
| 15. | 20EPE12 | Power Semiconductor Devices and Components | Employability |
| 16. | 20EPE13 | Solid State Power Controllers | Employability |
| 17. | 20EPE14 | Modelling and Simulation of Power Electronics Systems | Entrepreneur |
| 18. | 20EPE151 | Embedded Systems | Skill |
| 19. | 20EPE152 | Advanced Control Systems | Skill |
| 20. | 20EPE161 | PWM converters and applications | Employability |
| 21. | 20EPE162 | MPPT in solar systems | Employability |
| 22. | 20EPE163 | Electric Vehicle Technology | Entrepreneur |
| 23. | 20EPEL17 | Power Electronics Laboratory-1 | Skill |
| 24. | 20EPE21 | AC and DC Drives | Skill |
| 25. | 20EPE22 | Switched Mode Power Conversion | Employability |
| 26. | 20EPE23 | Power Electronics System Design Using Linear ICs | Skill |
| 27. | 20EPE24 | HVDC power Transmission | Employability |
| 28. | 20EPE263 | DSP applications to drives | Skill |

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Subject Title : POWER SEMICONDUCTOR DEVICES AND COMPONENTS

Sub.Code:20EPE12No. of Credits:03=03:0:0 (L - T - P)Exam Duration:03 HrsCIE+Asmt+SS+GA+SEE=30+10+5+5+50=100Course Learning Objectives:

No. of Lecture Hours/Week : 03 Total No.of Contact Hours:39

1 To analyse the working of basics power semiconductor devices

- 2 To analyse the working of power BJT and power MOSFET
- ³ To analyse the working of Thyristors, GTO and IGBT
- 4 To identify the types of protection circuits and their applications
- 5 To design the magnetic components based on the applications

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|---|----------------|-----------------------------|
| 1 | Basic Semiconductor Physics: Introduction, conduction processes in semiconductors pn junctions, charge control description of pn- junction operation, avalanche breakdown. Power Diodes: Introduction, Basic structure and I-V characteristics, breakdown voltage considerations, on – state losses, switching characteristics, schottky diodes. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 2 | Bipolar Junction Transistors: Introduction, vertical power transistor structures, I-V characteristics, physics of BJT operation, switching characteristics, breakdown voltages, second breakdown, on-state losses and safe operating areas. Power MOSFETs: Introduction, Basic structure, I-V characteristics, physics of device operation, switching characteristics, operating limitations and safe operating areas. TEXT 1 and TEXT 2. Reference Book 1 | 09 | L1,L2,L3. |
| 3 | Thyristors: Introduction, basic structure, I-V characteristics, physics of device operation, switching characteristics, methods of improving di/dt and dv/dt ratings. Gate Turn-Off Thyristors: Introduction, basic structure and I-V characteristics, physics of turn-off operation, GTO switching characteristics, over current protection of GTOs. Insulated Gate Bipolar Transistors: Introduction, basic structure, I- V characteristics, physics of device operation, latch up in IGBTs, switching characteristics, device limits and SOAs. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 4 | Emerging Devices and Circuits: Introduction, power junction field effect transistors, field-controlled thyristor, JFET-based devices | 07 | L1,L2,L3,L4 |

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| | versus other power devices, MOS-controlled thyristors, power integrated circuits, new semiconductor materials for power devices. Snubber Circuits: Function and types of snubber circuits, diode snubbers, snubber circuits for thyristors, need for snubbers with transistors, turn-off snubber, overvoltage snubber, turn-on snubber, snubbers for bridge circuit configurations, GTO snubber considerations. TEXT 1 and TEXT 2. Reference Book 1 | | |
| 5 | Component Temperature Control and Heat Sinks: Control of semiconductor device temperatures, heat transfer by conduction, heat sinks, heat transfer by radiation and convection. Design of Magnetic Components: magnetic materials and cores, copper windings, thermal considerations, analysis of a specific inductor design, inductor design procedures, analysis of a specific transformer design, eddy currents, transformer leakage inductance, transformer design procedure, comparison of transformer and inductor sizes. TEXT 1 and TEXT 2. Reference Book 1 | 07 | L1,L2,L3,L4 |

Note 1: Unit 1 to 5 will have internal choice

Note2: 1 Student has to submit one assignment per unit and is evaluated for 10 marks.

2 Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project and 5 marks for subject 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 working of various power semiconductor devices
- CO2 Understand the working and applications of BJT and Power MOSFET
- CO3 Understand the working and applications of Thyristors, GTO and IGBT
- CO4 Modeling and simulation of devices along with protection system
- CO5 Design the magnetic components based on the applications

Course Outcomes Mapping with Programme Outcomes.

| C1 N | G 0. | X 1 (D) T | X 01 0. 11 | Programme Outcome | | | | | | | | | | | |
|-------|----------------|--------------------------|--------------------------|-------------------|---|---|---|---|---|---|---|---|----|----|--|
| Sl.No | Course Outcome | Level of Blooms Taxonomy | No. of hours of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| 1. | CO1: | 2 | 08 | | 3 | 1 | 2 | | | | 2 | | 2 | 2 | |
| 2. | CO2. | 2 | 09 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 | |
| 3. | CO3: | 2 | 08 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 | |
| 4. | CO4: | 4 | 07 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 | |
| 5. | CO5: | 5 | 07 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 | |
| | Average CO | | | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 | |

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

Course Outcomes Mapping with Programme Specific Outcomes

Text Books.

- 1 Ned Mohan, "Power Electronics Converters, Applications, and Design", Third Edition, Wiley Publisher, 2014
- 2 Muhammad H. Rashid, "Power Electronics: Circuits, Devices & Applications", 4th edition, Pearson publisher, 2014

Reference Text Books.

1 Daniel W Hart, "Power Electronics", 2nd edition, McGraw Hill publisher, 2013

Web Links.

1 <u>https://books.google.co.in/books/about/Fundamentals_of_Power_Semiconductor_Devi.html</u> <u>id=UiqrUWrYZXkC&redir_esc=y</u>

Subject Title : SOLID STATE POWER CONVERTERS

Sub.Code:20EPE13No. of Credits:03=03:0:0 (L - T - P)Exam Duration:03 HrsCIE+Asmt+SS+SEE=30+10+05+05+50=100

No. of Lecture Hours/Week : 03 Total No.of Contact Hours:39

Course Learning Objectives:

- 1 To explain operating principle of various converters.
- 2 To control various inverters
- 3 To analyze and distinguish different types of inverters
- 4 To design different inverters and converters
- 5 To solve problems on different inverters

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|---|----------------|-----------------------------|
| 1 | Line Commutated Converters: Phase control, single phase semi- converter & fully controlled converter, three phase semi controlled & fully controlled converter, dual converters, effect of source inductance, single phase series converters, design of converter circuits. TEXT 1 and TEXT 2. | 8 | L1,L2, L3,L4 |
| 2 | Inverters: Principle of operation, performance parameters, single phase bridge inverters and three phase inverters. Current source inverter, comparison between VSI & CSI, series resonant inverters.TEXT 1 and TEXT3 | 7 | L1,L2,L3,L4 |
| 3 | Voltage Control of Inverters: Single/multiple, pulse/SPWM/ modified SPWM methods, voltage control of three phase inverter, SPWM/third harmonic PWM, harmonic reduction. TEXT 1 and TEXT 2. | 8 | L1,L2,L3 |
| 4 | Multilevel Inverters: Introduction, types, diode clamped multi-level inverters, features & applications. Capacitor clamped multilevel inverter, cascaded H-bridge multilevel inverter. TEXT 1 and TEXT 2 | 8 | L1,L2,L3 |
| 5 | DC-DC Converters: Principle of operation, analysis of step-down and step-up converters, Introduction to derived converters; transformer models, design of DC-DC Converters. TEXT 1 and Reference 1 | 8 | L1,L2,L3,L4 |

Note 1: Unit 1 to 5 will have internal choice

Note 2: Student has to submit one assignment per unit and is evaluated for 10 marks

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 To explain operating principle of various converters.
- CO2 To perform controlling of various inverters.

- CO3 To Analyze and distinguish different types of converters.
- CO4 To design different inverters and converters.
- CO5 To Solve problems on different converters.

Course Outcomes Mapping with Programme Outcomes.

| S1.No | Course | Level of Blooms | No. of hours | | | | Pro | gran | nme | Ou | tcor | ne | | |
|--------|------------|-----------------|--------------|---|---|---|-----|------|-----|----|------|----|----|----|
| 51.140 | Outcome | Taxonomy | of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | L1,L2 | 8 | 3 | 1 | 1 | | | | | | | | |
| 2. | CO2. | L1,L2,L4 | 7 | 1 | 3 | 1 | | | | | | | | |
| 3. | CO3: | L2,L4 | 8 | 1 | 3 | 1 | | | | | | | | |
| 4. | CO4: | L2,L4 | 8 | 1 | 1 | 3 | 1 | | | | | | | |
| 5. | CO5: | L2,L4 | 8 | | 1 | 3 | | | | | | | | |
| | Average CO | | | | 2 | 2 | 1 | | | | | | | |

Course Outcomes Mapping with Programme Specific Outcomes

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

Text Books.

- 1 Ned Mohan, Tore M. Undeland, William P. Robbins"**Power Electronics Converters, Applications, and Design**", Third Edition, Wiley India Pvt. Ltd, 2011
- 2 Rashid M.H, "Power Electronics Circuits Devices and Applications", 3rd Edition, Pearson, 2011.

Fang Lin Luo, Hong Ye, "Advanced DC/AC converters- Applications to Renewable Energy", 1st Edition, CRC2013.

Reference Text Books.

1 D K Bose"Modern Power Electronics & AC Drives", 1st edition, 2012

- 1 B. G. Fernandes" A course on Power Electronics" <u>http://nptel.ac.in/courses/108101038/</u>
- 2 Ramnarayan/Prof. L. Umanand "A course on Switched Mode Power Conversion") http://nptel.ac.in/courses/108108036
- 3 K. Gopakumar "A course on Industrial Drives Power Electronics" <u>http://nptel.ac.in/courses/108108077</u>

Subject Title : MODELING AND SIMULATION OF POWER ELECTRONICS SYSTEMS

Sub.Code:20EPE14

No. of Credits:03=03:0:0 (L - T - P)

Exam Duration:03 Hrs CIE+Asmt+SS+GA+SEE=30+10+5+5+50=100 Course Learning Objectives:

No. of Lecture Hours/Week: 03 Total No.of Contact Hours:39

Types of modeling applicable of power electronics 1

- Types and need for control system 2
- Control system design for converters 3
- To analyze a system and to make use of the information to improve the performance 4
- 5 To analyse a system numerically

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|---|----------------|-----------------------------|
| 1 | Computer Simulation of Power Electronic Converters and Systems: introduction, challenges in computer simulation, simulation process, mechanics of simulation, solution techniques for time-domain analysis, widely used, circuit-oriented simulators, equation solvers. Modelling of Systems: input-output relations, differential equations and linearization, state space representation, transfer function representation, block diagrams, circuit averaging, bond graphs, space vector modelling TEXT 1 and TEXT 2. Reference Book 1 | 10 | L1,L2,L3. |
| 2 | Control System Essentials: control system basics, control principles, state - space method, bode diagram method, root locus method, state space method. TEXT 1 and TEXT 2. Reference Book 1 | 07 | L1,L2,L3. |
| 3 | Digital Controller Design: controller design techniques, PID controller, full state feedback, regulator design by pole placement, estimation design, tracker: controller design, controlling voltage, controlling current, control of induction motor. TEXT 1 and TEXT 2. Reference Book 1 | 07 | L1,L2,L3. |
| 4 | Optimal and Robust Controller Design: least squares principle, quadratic forms, minimum energy principle, least square solution, weighted least squares, recursive least squares, optimal control: linear quadratic, induction motor example, robust controller design. TEXT 1 and TEXT 2. Reference Book 1 | 07 | L1,L2,L3,L4 |
| 5 | Discrete Computation Essentials: numeric formats, tracking the base point in the fixed point system, normalization and scaling, arithmetic algorithms. TEXT 1 and TEXT 2. Reference Book 1 1: Unit 1 to 5 will have internal choice | 08 | L1,L2,L3,L4 |

Unit 1 to 5 will have internal choice Note 1:

Student has to submit one assignment per unit and is evaluated for 10 marks Group Note2: Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project and 5 marks for subject seminar

Out of 5 Units, Unit3is a Webinar unit conducted through Google Note:3 Classroom/Zoom/Cisco Webex etc and will be delivered by subject faculty

Course Outcomes:

- CO1 Understand the types of modeling applicable of power electronics
- CO2 Understand the types and need for control systems
- CO3 Design the control system for converters
- CO4 Modelling and simulation of devices along with protection system
- CO5 Verify a system analytically

Course Outcomes Mapping with Programme Outcomes.

| | Course | Level of Blooms | No. of hours of | | | | Pro | grar | nme | Ou | tcon | ne | | |
|-------|------------------|-----------------|-----------------|---|---|---|-----|------|-----|----|------|----|----|----|
| Sl.No | Outcome Taxonomy | Taxonomy | teaching | | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | 2 | 10 | | 3 | 1 | 2 | | | | 2 | | 2 | |
| 2. | CO2. | 2 | 07 | 1 | 3 | 1 | 2 | | | | 2 | | 2 | 3 |
| 3. | CO3: | 4 | 07 | 1 | 3 | 1 | 2 | | | | 2 | | 2 | 3 |
| 4. | CO4: | 4 | 07 | 1 | 3 | 1 | 2 | | | | 2 | | 2 | 3 |
| 5. | CO5: | 4 | 08 | 1 | 3 | 1 | 2 | | | | 2 | | 2 | 3 |
| | Average CO | | | 1 | 3 | 1 | 2 | | | | 2 | | 2 | 3 |

Course Outcomes Mapping with Programme Specific Outcomes

| Course Outcome | PSO1 | PSO2 | PSO3 |
|----------------|------|------|------|
| CO1 | | 1 | 2 |
| CO2 | | 2 | 2 |
| C03 | 1 | 2 | 2 |
| CO4 | 2 | 2 | 2 |
| CO5 | 2 | 2 | 2 |
| Average CO | 2 | 2 | 2 |

Text Books.

- 1 Ned Mohan, "Power Electronics Converters, Applications, and Design", Third Edition, Wiley Publisher, 2014
- 2 L. Umanand, "Power Electronics Essentials and Applications", 1stedition, Pearson publisher, 2014

Reference Text Books.

1 M. Godoy Simoes, Felix A. Farret, "Modeling Power Electronics and Interfacing Energy Conversion Systems", 1stedition, Wiley publisher, 2016

- 1 https://vtechworks.lib.vt.edu/handle/10919/31026
- 2 https://ieeexplore.ieee.org/document/931486 Subject Title : EMBEDDED SYSTEMS

Sub.Code:20EPE151

Exam Duration:03 Hrs CIE+Asmt+SS+GA+SEE=30+10+5+5+50=100 Total No.of Contact Hours:39 Course Learning Objectives:

- 1 Describe the functional blocks of a typical embedded system.
- 2 Describe the fundamental issues involved in hardware, software co-designs, embedded hardware and firmware, design and development approaches.
- 3 Embedded system architecture and memory organization.
- 4 The interprocess communication, modeling, devices and communication buses.
- 5 Explain the fundamentals of real time operating systems and latest trends in ES domain and use it to the present need.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|---|----------------|-----------------------------|
| 1 | Introduction to Embedded Systems: embedded systems, processor embedded into a system, embedded hardware units and devices in a system, embedded software in a system, examples of embedded systems, embedded systems – on –chip (soc) and use of VLSI circuit design technology, design process and design examples, Communication Interfaces, classification of embedded systems, skill required for an embedded system designer. -Write a program to toggle all the led to port and with some time delay using ARM7. TEXT 1 and TEXT 2. Reference Book 1 | 07 | L1,L2 |
| 2 | Processor Architecture and Memory Organisation: introduction to advanced architecture, processor and memory organization, performance metrics, memory – types, memory – maps and addresses, processor selection, memory selection, Memory Management of External Memory, Board Memory and performance Basic Steps involved in PCB design. -Write a program to interface 4*4 matrix keypad with ARM7. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 3 | Devices and Communication Buses, Interrupt Services: IO types and examples, serial communication devices, parallel device ports, sophisticated interfacing features in device ports, wireless devices, timer and counting devices, watchdog timer, real time clock Device Drivers and Interrupts Service Mechanisms: Programmed – I/O busy – wait approach without interrupt service mechanism, ISR concept, interrupt sources, interrupt servicing mechanism, direct memory access. | 08 | L1,L2,L3. |

| | -Write a program to verify Timer operation in different | | | | | | | |
|-------|---|----|-------------|--|--|--|--|--|
| | modes | | | | | | | |
| | | | | | | | | |
| | TEXT 1 and TEXT 2. Reference Book 3 | | | | | | | |
| | Program Modeling Concepts: Program models, DFG | | | | | | | |
| | models, state machine programming models for event - | | | | | | | |
| | controlled program flow. | | | | | | | |
| | Interprocess Communication and Synchronization of | | | | | | | |
| | Processes, Threads and Tasks: multiple processes in an | | | | | | | |
| 4 | application, multiple threads in an application, tasks, task | 08 | L1,L2,L3,L4 | | | | | |
| | status, task and data, clear - cut dissention between | | | | | | | |
| | functions, ISRS and tasks by their characteristics, concept of | | | | | | | |
| | semaphores. | | | | | | | |
| | -Write a program to interface Stepper motor with ARM7 | | | | | | | |
| | TEXT 1 and TEXT 2. Reference Book 1 | | | | | | | |
| | Real-Time Operating Systems: OS services, process | | | | | | | |
| | management, timer functions, event functions, memory | | | | | | | |
| | management, device, file and, real – time operating systems, | | | | | | | |
| | basic design using an RTOS, RTOS task scheduling models, | | | | | | | |
| 5 | interrupt latency and response of the task as performance | 08 | L1,L2,L3,L4 | | | | | |
| | metrics, Task Synchronization, Multiprocessing and | | | | | | | |
| | Multitasking. OS security issues. | | | | | | | |
| | - Write a program for interfacing of DC motor with ARM7 | | | | | | | |
| | TEXT 1 and TEXT 2. Reference Book 2 | | | | | | | |
| Note | 1: Unit 1 to 5 will have internal choice | | | | | | | |
| Note? | Note2: Two assignments are evaluated for 10 marks: Assignment -1 Two assignments | | | | | | | |

are evaluated for 5 marks: Assignment -1 from Units 1 and 2. Assignment -2

from Units 3, 4 and 5 Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project and 5 marks for subject seminar

Out of 5 Units, Unit 2 is a Webinar unit and will be delivered by subject Note:3 faculty.

Course Outcomes:

- CO1 Understand the concept of embedded system.
- CO2 Analyse the embedded system architecture and memory organization.
- CO3 Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems.
- CO4 Analyse Device Drivers and Interrupts Service Mechanisms
- CO5 Design real time embedded systems using the concepts of RTOS and Analyse various real time applications of embedded system design.

Course Outcomes Mapping with Programme Outcomes.

| G1) I | Course | Level | of | | of | Pro | ogra | mm | e Oi | utco | me | | | | | |
|---------------|---------|--------------------|----|----------------|----|-----|------|----|------|------|----|---|---|---|----|----|
| Sl.No | Outcome | Blooms Taxonomy | | hours teaching | of | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1 | 1 | | 07 | | | 2 | 3 | 2 | 3 | | | 2 | | | |

| 2. | CO2 | 4 | 08 | 3 | 3 | 3 | 3 | 3 | | 2 | 1 | 2 | 2 |
|-------|-------|---|----|---|---|---|---|---|---|---|---|---|---|
| 3. | CO3 | 2 | 08 | 3 | 3 | 2 | 3 | | | 2 | 1 | 3 | 1 |
| 4. | CO4 | 4 | 08 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | 3 |
| 5. | CO5 | 5 | 08 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | | 2 | 2 |
| Avera | ge CO | | | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 2 |

Course Outcomes Mapping with Programme Specific Outcomes

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

Text Books.

- 1 Raj Kamal, "Embedded Systems: Architecture, Programming and Design", Second Edition, McGraw Hill, 2014
- 2 Frank Vahid/Tony Givargis, "A Unified Hardware/Software Introduction, Wiley student edition 2002.

Reference Text Books.

- 1 Michael J. Pont, "Embedded C", 2nd Edition, Pearson Education, 2008
- 2 Nigel Gardner, "The Microchip PIC in CCS C", 2nd Revision Edition, Ccs Inc, 2002
- 3 Embedded Software Premier. Simon David, Addison Wessly 2000

- 1 Motorola and Intel Manuals
- 2 www.nptel.com

Subject Title : ADVANCED CONTROL SYSTEMS

| Sub.Code:20EPE152 | No. of Credits: $03=03:0:0 (L - T - P)$ |
|----------------------|---|
| Exam Duration:03 Hrs | CIE+Asmt+GA+SEE=40+5+5+50=100 |

No. of Lecture Hours/Week 03 Total No .of Contact Hours:39

Course Learning Objectives:

- 1 To explain the concepts of basic and digital control system for the real time analysis and design of control systems
- 2 The Modeling of Digital Control Systems.
- 3 To explain and apply concepts of state variables analysis..
- 4 The Optimization of the control parameters using different optimization techniques.
- 5 To study and analyze nonlinear systems.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| 1 | Digital Control: Control System Terminology, Need of Digital control, Configurations of the Basic Digital Control Scheme, Principle of Signal Conversion, Basic Discrete – Time Signals, Time Domain Models for Discrete – Time Systems, The z – Transform, Transfer Function Models, Frequency Response, Stability on the z – Plane and Jury Stability Criterion, Sample and Hold Systems, Sampled Spectra and Aliasing, Reconstruction of Analog Signals, Practical Aspects of the choice of Sampling Rate, Principle of Discretization. TEXT 1 and TEXT 2. Reference Book | 08 | L1,L2,L3,L4 |
| 2 | Models of Digital Control Devices and Systems: Introduction, z–Domain Description of Sampled Continuous – time Plants, z – Domain Description of Samples with Dead – Time, Implementation of Digital Controllers, Tunable PID Controllers, Digital Temperature and Position Control Systems, Stepping Motors and their Control. TEXT 1 and TEXT 2. Reference Book | 08 | L1,L2,L3,L4 |
| 3 | State Variable Analysis of Digital Control Systems: Introduction, State Description of Digital Processors, State Description of Sampled continuous – Time Plants, State Description of Systems with Dead Time, Solution of State Difference Equations, Controllability and Observability, Multivariable Systems. TEXT 1 and TEXT 2. Reference Book | 06 | L1,L2,L3,L4 |
| 4 | Quadratic Optimal Control: Introduction, The Concept of Lyapunov Stability, Lyapunov Functions for Linear Systems, Parameter Optimization and Optimal Control Problems, Quadratic Performance Index, Control Configurations, Optimal State Regulator, Optimal Digital Control Systems, Constrained State Feedback Control. TEXT 1 and TEXT 2. Reference Book | 08 | L1,L2,L3,L4 |

| 5 | Nonlinear System Analysis: Introduction, Common nonlinear System Behaviours, Common nonlinearities in Control Systems, Describing Function Fundamentals, Describing Function of Common nonlinearities, Stability Analysis by the Describing Function Method, Concept of Phase Plane Analysis, Construction of Phase Portraits, System Analysis on the Phase Plane, Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems TEXT 1 and TEXT 2. Reference Book | 09 | L1,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
 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 Analyze the Digital Control Systems.
- CO2 Understand the modelling of Digital Control devices and systems.
- CO3 Understand the fundamentals of state variables, linear and nonlinear systems.
- CO4 Optimize the control parameters using different optimization techniques.
- CO5 Understand and analyse the nonlinear systems

Course Outcomes Mapping with Programme Outcomes.

| Sl.No | Course | Level of Blooms No. of hours of | Programme Outcome | | | | | | | | | | | |
|---------|------------|---------------------------------|-------------------|---|---|---|---|---|---|---|---|---|----|----|
| 51.100 | Outcome | Taxonomy | teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1:. | 4 | 10 | 3 | 3 | 3 | | 2 | | | 2 | 2 | 2 | |
| 2. | CO2. | 2 | 10 | 3 | 3 | 3 | | 2 | | | 2 | 2 | 2 | |
| 3. | CO3: | 2 | 12 | 3 | 3 | 3 | | 2 | | | 2 | 2 | 2 | |
| 4. | CO4: | 4 | 12 | 3 | 3 | 3 | | 2 | | | 2 | 2 | 2 | |
| 5. | CO5: | 4 | 8 | 3 | 3 | 3 | | 2 | | | 2 | 2 | 2 | |
| Average | Average CO | | | 3 | 3 | 3 | | 2 | | | 2 | 2 | 2 | |

Course Outcomes Mapping with Programme System 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 and State Variable Methods (Conventional and Intelligent Control Systems)", 3rd Edition, McGraw Hill, 2008
- 2 Katsuhiko Ogata, "Modern Control Engineering", 5th Edition, Prentice Hall India, 1997

Reference Text Books.

- 1 Benjamin C Kuo, "Digital Control Systems", 2ndedition, Oxford University Press, 2007
- 2 Katsuhiko Ogata, "State Space Analysis of Control Systems", 5th edition PHI, 1997 Web Links.
- 1 https://www.researchgate.net/publication/331258428_Advanced_Control_Systems_E ngineering_Tutorial_One
- 2 https://nptel.ac.in/courses/108/103/108103007/
- 3 https://www.electronics-tutorial.net/control-systems/
- 4 http://www.ent.mrt.ac.lk/~rohan/teaching/EN5001/Reading/DORFCH1.pdf
- 5 https://ecetutorials.com/control-systems/

Subject Title : PWM CONVERTERS AND APPLICATIONS

Sub.Code:20EPE161 Exam Duration:03 Hrs No. of Credits:03=03:0:0 (L - T – P) CIE+Asmt+SS+GA+SEE=30+10+5+5+50=100 No. of Lecture Hours/Week : 03 Total No.of Contact Hours:39

22

Course Learning Objectives:

- 1 AC/DC and DC/AC Power Conversion
- 2 Different PWM Techniques
- 3 Computation of switching Losses
- 4 Dynamic Modeling of PWM converters
- 5 Different compensation techniques

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| 1 | AC/DC and DC/AC Power Conversion: Overview of applications of voltage source converters. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 2 | PWM Techniques: Pulse modulation techniques for I – phase bridges, bus clamping PWM, space vector based PWM, advanced PWM techniques. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 3 | Loss Calculations: Practical devices in converters, calculation of switching and conduction losses, compensation for dead time and DC voltage regulation. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 4 | Modelling: Dynamic model of PWM converters; constant V/F induction motor drives; estimation of current ripple and torque ripple in inverter fed drives. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3,L4 |
| 5 | Converters with Compensation: Line-side converters with power factor compensation, reactive power compensation, harmonic current compensation TEXT 1 and TEXT 2. Reference Book 1 | 07 | L1,L2,L3 |

Note 1: Unit 1 to 5 will have internal choice

Note2: Student has to submit one assignment per unit and is evaluated for 10 marks. Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/ Project and 5 marks for subject 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 applications of AC/DC and DC/AC Power Conversion

CO2 Analyse different PWM Techniques

CO3 Compute switching and conduction losses

- CO4 Implement dynamic modeling of PWM converters
- CO5 Discuss different compensation techniques

Course Outcomes Mapping with Programme Outcomes.

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

Course Outcomes Mapping with Programme Specific Outcomes

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

Text Books.

- 1 Mohan, Undeland and Robbins, "Power Electronics: Converter, Applications and Design", Third Edition, Wiley Publisher, 2011
- 2 Erickson RW, "Fundamentals of Power Electronics", 1st edition, Chapman Hall, 1997

Reference Text Books.

1 Joseph Vithyathil, "Power Electronics- Principles and Applications", 1st edition, TMH, 2011

Web Links.

- 1 https://onlinelibrary.wiley.com/doi/book/10.1002/9781118886953
- 2 <u>https://books.google.co.in/books/about/Power_Electronic_Converters.html?id=5vTtWUOn</u> <u>60AC&redir_esc=y</u>

Subject Title : MPPT IN SOLAR SYSTEMS

| Sub.Code:20EPE162 | No. of Credits: $03=03:0:0 (L - T - P)$ | No. of Lecture Hours/Week : 03 |
|----------------------|---|--------------------------------|
| Exam Duration:03 Hrs | CIE+Asmt+SS+GA+SEE=30+10+5+5+50=100 | Total No.of Contact Hours:39 |

Course Learning Objectives:

- 1 To explain the PV cell, its characteristics and its models, equivalent circuits and circuit parameter calculations.
- 2 To explain different methods of tracking maximum power point and effect of noise on MPPT and reduction of noise
- 3 To explain distributed Maximum Power Point Tracking of PV arrays and its DC analysis
- 4 To explain distributed Maximum Power Point Tracking of PV arrays and its AC analysis
- 5 To explain the design of high energy efficiency power converters for PV MPPT.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|---|----------------|-----------------------------|
| 1 | PV Modelling: From the Photovoltaic Cell to the Field, The Electrical Characteristic of a PV Module, The Double-Diode and Single-Diode Models, From Data Sheet Values to Model Parameters, Example: PV Module Equivalent Circuit Parameters Calculation, The Lambert W Function for Modelling a PV Field, Example. Maximum Power Point Tracking: The Dynamic Optimization Problem, Fractional Open-Circuit Voltage and Short-Circuit Current, Soft Computing Methods, The Perturb and Observe Approach TEXT 1 and TEXT 2. Reference Book1 | 08 | L1,L2,L3. |
| 2 | Maximum Power Point Tracking (continued): Improvements of the P&O Algorithm, Evolution of the Perturbative Method, PV MPPT via Output Parameters, MPPT Efficiency. MPPT Efficiency: Noise Sources and Methods for Reducing their Effects: Low-Frequency Disturbances in Single-Phase Applications, Instability of the Current-Based MPPT Algorithms, Sliding Mode in PV System, Analysis of the MPPT Performances in a Noisy Environment, Numerical Example. TEXT 1 and TEXT 2. Reference Book1 | 08 | L1,L2,L3. |
| 3 | Distributed Maximum Power Point Tracking of Photovoltaic Arrays: Limitations of Standard MPPT, A New Approach: Distributed MPPT, DC Analysis of a PV Array with DMPPT, Optimal Operating Range of the DC Inverter Input Voltage. TEXT 1 and TEXT 2. Reference Book1 | 08 | L1,L2,L3. |
| 4 | Distributed Maximum Power Point Tracking of Photovoltaic Arrays (continued): AC Analysis of a PV Array with DMPPT TEXT 1 and TEXT 2. Reference Book1 | 07 | L1,L2,L3. |
| 5 | Design of High-Energy-Efficiency Power Converters for PV MPPT Applications: Introduction, Power, Energy, Efficiency, EnergyHarvesting in PV Plant Using DMPPT Power Converters, Losses in Power Converters, Losses in the Synchronous FET Switching Cells, Conduction Losses, Switching Losses TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |

Note 1: Unit 1 to 5 will have internal choice

- Note2: Student has to submit one assignment per unit and is evaluated for 10 marks and Group Activity for 5 Marks has to be evaluated through PPT Presentation/ Subject Quiz/Project and 5 marks for subject 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 Understand the characteristics of a PV cell and its models, equivalent circuits and circuit parameter calculations.
- CO2 Understand the different methods of tracking maximum power point and distributed MPPT.
- CO3 Identify the sources of noise, effect of noise on MPPT and reduction of noise
- CO4 Analyse the differences between AC and DC analysis of PV array with DMPPT
- CO5 Understand the use of high energy efficiency power converters for PV MPPT application.

Course Outcomes Mapping with Programme Outcomes.

| | Course | Level of Blooms | No. of hours | | | | Pro | grar | nme | Ou | tcor | ne | | |
|------------|---------|-----------------|--------------|---|---|---|-----|------|-----|----|------|----|----|----|
| Sl.No | Outcome | Taxonomy | of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | 2 | 08 | | 1 | 1 | 2 | | | | 1 | | 1 | |
| 2. | CO2. | 2 | 08 | 2 | 2 | 1 | 3 | | | | 2 | | 2 | 2 |
| 3. | CO3: | 3 | 08 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | |
| 4. | CO4: | 4 | 07 | 1 | 2 | 1 | 2 | | | | 2 | | 2 | 2 |
| 5. | CO5: | 3 | 08 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | |
| Average CO | | | 2 | 2 | 1 | 2 | | | | 2 | | 2 | 1 | |

Course Outcomes Mapping with Programme Specific Outcomes

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

Text Books.

- 1 Nicola Femia et al, "Power electronics and Control Techniques for Maximum energy harvesting in Photovoltaic systems", first Edition, IEEE press and John Wiley & Sons CRC Press, 2013
- 2 Kamal Kant Sharma, Satya Nand Vishwakarma, Gaziz Manzoor, "Hybrid PSD-GSA Based MPPT Algorithm for Photovoltaic System Understanding FACTS: Concepts and

Technology of Flexible AC Transmission Systems", 1st edition, Published by Independently , 2019

Reference Text Books.

1 Kamal Kant Sharma, "Hyrid PSD-GSA Based MPPT Algorithm for Photovoltaic Systems", 1st edition, Published by Independently, 2015

- ¹ https://www.intechopen.com/books/recent-developments-in-photovoltaic-materials-anddevices/improved-performance-of-a-photovoltaic-panel-by-mppt-algorithms
- ² https://www.researchgate.net/publication/317723124_Designing_and_implementation_of_ maximum_power_point_trackingMPPT_solar_charge_controller

Subject Title : ELECTRIC VEHICLE TECHNOLOGY

| Sub.Code:20EPE163 | No. of Credits: $03=03:0:0 (L - T - P)$ | No. of Lecture Hours/Week : 03 |
|--------------------------|---|--------------------------------|
| Exam Duration:03 Hrs | CIE+Asmt+SS+GA+SEE=30+10+05+05+50=100 | Total No.of Contact Hours:39 |
| Course Learning Objectiv | es: | |

- 1 Advantages of EVs.
- 2 Various drive trains
- 3 Characteristics of various types of batteries.
- 4 Concept of hybrid electric vehicles
- 5 Emerging technology of EV's

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| 1 | Introduction to electric vehicles (EVs): EV advantages and impacts. EV regulations and standardization. Electric vehicle (EV) design options: EV con figurations: fixed vs. variable gearing, single- vs. multiple-motor drive, in-wheel drives. EV parameters, driving cycles and performance specifications. Choice of system voltage levels: electrical safety and protection. TEXT 1 and TEXT 2. Reference 1 | 8 | L1,L2, L3,L4 |
| 2 | Vehicle dynamics and motor drives: Road load: vehicle kinetics; effect of velocity, acceleration and grade. EV drive train and components. EV motor drive systems: DC drives, induction motor drives, switched reluctance motor drives, control strategies. TEXT 1 and TEXT 2. Reference 1 | 8 | L1,L2,L3,L4 |
| 3 | Batteries: Battery parameters, types and characteristics of EV batteries. Charging schemes. Open-circuit voltage and ampere- hour estimation. Battery load levelling TEXT 1 and TEXT 2. Reference 1 | 8 | L1,L2,L3 |
| 4 | Emerging EV technologies: Hybrid electric vehicles (HEVs): types, operating modes, torque coordination and control, generator/motor requirements. TEXT 1 and TEXT 2. Reference 1 | 9 | L1,L2,L3 |
| 5 | Fuel cell electric vehicles (FEVs): Fuel cell characteristics, hydrogen storage systems, ultra- capacitors. TEXT 1 and TEXT 2. Reference 1 | 6 | L2,L3,L4 |
| Note | 1 : Unit 1 to 5 will have internal choice | | |

Student has to submit one assignment per unit and is evaluated for 10 marks and Note2: group activity for 5 marks and Seminar for 5 Marks

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

Course Outcomes:

- CO1 Describe the configuration of a typical electric vehicle
- CO2 Differentiate among different drive trains
- CO3 Understand the limitations and advantages of various battery chemistries.
- CO4 Develop strategies for charging various types of batteries.
- CO5 Describe the various drive trains of hybrid electric vehicles.

Course Outcomes Mapping with Programme Outcomes.

| S1.No | Course | Level of Blooms | No. of hours | | | | Pro | grar | nme | Ou | tcor | ne | | |
|--------|------------|-----------------|--------------|---|---|---|-----|------|-----|----|------|----|----|----|
| 51.140 | Outcome | Taxonomy | of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | L1,L2 | 8 | 1 | 3 | 1 | | | | | | | | |
| 2. | CO2. | L1,L2 | 8 | 1 | 3 | 1 | | | | | | | | |
| 3. | CO3: | L1,L2 | 8 | 3 | 1 | 1 | | | | | | | | |
| 4. | CO4: | L2,L3 | 9 | | 3 | 1 | 1 | | | | | | | |
| 5. | CO5: | L2,L3 | 6 | 1 | 3 | 1 | | | | | | | | |
| | Average CO | | | | 3 | 1 | 1 | | | | | | | |

Course Outcomes Mapping with Programme Specific Outcomes

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

Text Books.

- 1 C.C. Chan and K.T. Chau**"Modern Electric Vehicle Technology"**,1st edition Oxford University Press, London, 2001
- 2 Iqbal Husain "Electric and Hybrid Vehicles"1stedition New York: CRC Press, 2016.

Reference Text Books.

 M. Ehsani, Y. Gao, S.E. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design, 1st edition New York: CRC Press, 2004

Web Links.

1. Prof. Amit Jain"Electrical Vehicle part 1" http://nptel.ac.in/courses

Subject Title : POWER ELECTRONICS LABORATORY-I

Sub.Code:**20EPEL17** Exam Duration:3 Hrs No. of Credits:2=0:0:2(L - T - P) CIE +SEE=50+50=100 No. of Lecture Hours/Week :03 Total No.of Contact Hours:30

Course Learning Objectives:

- 1 To conduct experiments on various converters and devices.
- 2 To analyse various parameters of converters.
- 3 To compute the performance of various converters.
- 4 To understand the working of controlled converters.
- 5 To compare dynamic characteristics of switching devices.

| Expt .No | Experiments | No.of Hours | Blooms Taxnomy level. |
|-------------|--|----------------|-----------------------------|
| 1 | Analysis of static and dynamic characteristic of MOSFET and IGBT | 3 | L2,L4 |
| 2 | Performance of single phase fully controlled and semi-controlled converter for RL load for continuous current mode. | 3 | L1,L2,L3. |
| 3 | Performance of single phase fully controlled and semi-controlled converter for RL load for discontinuous current mode. | 3 | L1, L2, L3 |
| 4 | Study of effect of source inductance on the performance of single phase fully controlled converter. | 3 | L1, L2, L3 |
| 5 | Performance analysis of three phase fully controlled and semi- controlled converter for RL load for continuous current mode. | 3 | L2, L3, L4 |
| 6 | Performance analysis of three phase fully controlled and semi- controlled converter for RL load for discontinuous current mode. | 3 | L2, L3, L4 |
| 7. | Performance analysis of single phase bridge inverter for RL load and voltage control by single pulse width modulation. | 3 | L2, L3, L4 |
| 8. | Performance analysis of two quadrant chopper. | 3 | L2, L3, L4 |
| 9 | Diode clamped multilevel inverter. | 3 | L1, L2, L3 |
| 10 | ZVS operation of a synchronous buck converter. | 3 | L1, L2, L3 |
| 11 | *Simulation of converters using NgSpice open source. | | |

Note 1: Laboratory report should be submitted to the subject faculty every week and evaluation will be done on the same week only. * Experiment is for additional skill not for exam.

Course Outcomes:

- CO1 To conduct experiments on various converters and devices.
- CO2 To compare dynamic characteristics of switching devices.
- CO3 To compute the performance of various converter.
- CO4 To understand the working of controlled converters.
- CO5 To analyse various parameters of converters.

Course outcomes Mapping with programme outcomes

| S1 No | Course | Level of Blooms | No. of hours of | f Programme Outcom | | | | | ne | | | | | |
|-------|---------|-----------------|-----------------|--------------------|---|---|---|---|----|---|---|---|----|----|
| Sl.No | Outcome | Taxonomy | teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | L1,L2 | 06 | 3 | | 1 | | | 1 | | | | | 1 |
| 2. | CO2: | L2,L3 | 06 | | 3 | 1 | | | 1 | | | | | 1 |
| 3. | CO3: | L2,L3 | 06 | | | 3 | | | 1 | | | | | 1 |
| 4. | CO4: | L1,L2 | 06 | 3 | 1 | | | | | | | | | |
| 5. | CO5: | L2,L4 | 06 | 1 | 3 | | | | | | | | | |
| | | | Average CO | 2 | 3 | 2 | | | 1 | | | | | 1 |

Course Outcomes Mapping with Programme Specific Outcomes

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

References Text Books.

- 1 Ned Mohan, Tore M. Undeland, William P. Robbins"**Power Electronics Converters, Applications, and Design**", Third Edition, Wiley India Pvt. Ltd, 2011
- 2 Rashid M.H, "Power Electronics Circuits Devices and Applications", 3rd Edition, Pearson, 2011.

D K Bose"Modern Power Electronics & AC Drives", 1st edition, 2012

Web Links.

1 B. G. Fernandes" A course on Power Electronics" http://nptel.ac.in/courses/108101038/

2. K. Gopakumar "A course on Industrial Drives – Power Electronics" <u>http://nptel.ac.in/courses/108108077</u>

| Sub.Code: 20EPE21 | No. of Credits: $03=03:0:0 (L - T - P)$ |
|----------------------|---|
| Exam Duration:03 Hrs | CIE+Asmt+SS+GA+SEE=30+10+5+5+50=100 |

Course Learning Objectives:

- 1 Different Quadrant operation of Drives..
- 2 The concept of DC variable speed drives.
- 3 Different control methods of AC drives.
- 4 Closed loop Control of AC Drives
- 5 Control Techniques using Microprocessor/Microcontroller

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| 1 | Electric Drives: Introduction – block diagram-classification of electrical drivesfundamental torque equation- components of load torque- steady state stability. TEXT 1 and TEXT 2. Reference Book 1 | 8 | L1,L2,L3. |
| 2 | DC Drives: Two quadrants Drive: 1-phase and 3-phase full converter drive. Four Quadrant drive: Three- phase dual converter drive. Different braking methods and closed loop control of DC drives. TEXT 1 and TEXT 2. Reference Book 2 | 8 | L1,L2,L3. |
| 3 | AC Drives: Voltage and current source inverter - inverter control-six step and PWM operation, Control of Induction motor drive -V/f and field oriented control – direct and indirect vector control, voltage and current source inverter fed induction motor drives, stator and rotor voltage control methods, slip energy recovery drives. TEXT 1 and TEXT 2. Reference Book 1 | 8 | L1,L2,L3. |
| 4 | Closed Loop Control of AC Drives: Basic Principle of Vector Control, Direct & Indirect Vector control of Induction Motor, Stator voltage control, Slip regulation and Speed control of static Kramer's drive. TEXT 1 and TEXT 2. Reference Book 3 | 8 | L1,L2,L3. |
| 5 | Microcontroller Control of Electric Drives: Introduction to Microcontroller, Timers, Interrupts, ADC and DAC, Control of DC drives using microcontroller, Microcontroller based regular sampled PWM control using three timer control and four timer control. Control of VSI- Induction motor drives using Microcontroller. TEXT 3 Reference Book 2 | 7 | L1,L2,L3. |
| Note 1 | | L | <u> </u> |

Note2: Student has to submit one assignment per unit and is evaluated for 10 marks and group activity for 5 marks and Seminar for 5 Marks

Note:3Out 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 Acquainted with the knowledge of various AC/DC drives
- CO2 Demonstrate the knowledge of different quadrant operation of AC/DC drives.
- CO3 Demonstrate the different methods of AC drives control.
- CO4 Develop the closed loop control of Electrical Drives.

CO5 Acquainted the knowledge of using microprocessor for Drive control.

Course Outcomes Mapping with Programme Outcomes.

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

Text Books.

- 1 B K Bose, "Modern Power Electronics & AC Drives", 2nd edition, PHI, 2011
- 2 R Krishnan, "Electric Motor Drives", 2nd edition, PHI, 2010
- 3 IEEE Transactions on Industry Applications, "Simple Microprocessor Implementation of New Regular Sampled Harmonic Elimination PWM Techniques,", Vol 28, No.1, Jan/Feb 1992, pp.89-94

Reference Text Books.

- 1 Murphy JMD, Turnbull F.G., "Thyristor Control of AC Motors", Third edition, Pergamon Press Oxford, 1998, Choose an item.
- 2 MehrdadEhsani, YiminGaoAlinEmadi, "High Performance Control of AC Drives, Wiley 2012
- 3 Muhammad H. Rashid, "Power Electronics- Circuits, Devices and Applications, Pearson Prentice Hall, 2010.

- 1 https://www.academia.edu/26714897/R_Krishnan_Electric_Motor_Drives_Modeling_Analysis_and_Control_2001_
- ² https://www.pdfdrive.com/modern-power-electronics-and-ac-drives-e18928858.html
- ³ file:///C:/Users/EEE/Downloads/32_Sample_Chapter.pdf

Subject Title : SWITCHED MODE POWER CONVERSION

 Sub.Code:20EPE22
 No. of Credits:03=03:0:0 (L - T - P)

 Exam Duration:03 Hrs
 CIE+Asmt+SS+GA+SEE=30+10+05+05+50=100

No. of Lecture Hours/Week : 03 Total No.of Contact Hours:39

Course Learning Objectives:

- 1 To explain operating principle of various converters.
- 2 To design transformer and inductor for Dc-DC converter
- 3 To analyze and distinguish different power converters
- 4 To design different power converters.
- 5 To solve problems on different power converters.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| 1 | DC – DC Converters (Basic Converters): Linear voltage regulators (LVRs), a basic switching converter(SMPC), comparison between LVR & SMPC, principle of operation and analysis of buck converter analysis, inductor current ripple and output voltage ripple, capacitor resistance effect, synchronous rectification, design considerations, buck converter for discontinuous current operation, principle of operation and analysis of boost converter, inductor current ripple and output voltage ripple, inductor resistance effect, design considerations, boost converter for discontinuous current operation, principle of operation and analysis of boost converter, inductor current ripple and output voltage ripple, inductor resistance effect, design considerations, boost converter for discontinuous current operation and analysis of buck boost converter analysis, inductors current ripple and output voltage ripple, design considerations for continuous current mode operation.Buck-boost converter for discontinuous current operation. TEXT 1 and Text 2 Reference 1 | 8 | L1,L2, L3,L4 |
| 2 | Principle of operation and analysis of CUK converter, inductor current ripple and output voltage ripple, capacitor resistance effect, design considerations, single ended primary inductance converter(SEPIC). Derived Converters: Introduction, transformer models, principle of operation and analysis of fly back converter-continuous and discontinuous current mode of operation, design considerations, principle of operation and analysis of forward converter, design considerations. TEXT 1 and Text 2 Reference 1 | 7 | L2,L3,L4 |
| 3 | Principle of operation and analysis of push-pull converter, design considerations, principle of operation and analysis of full bridge and half- bridge DC-DC converters, design considerations, current fed converters, multiple outputs. TEXT 1 and TEXT 2. | 8 | L2,L3,L4 |
| 4 | Control of DC-DC Converter: Modeling of DC-DC converters, power supply control, control loop stability, small signal analysis, switch transfer function, filter transfer function, PWM transfer function, Type-2 error amplifier with compensation, Type-3 error amplifier with compensation, design. TEXT 1 and TEXT 2. Reference Book 3 | 8 | L2,L3,L4 |

| Resonant Converters: Introduction, resonant switch ZCS converter, principle of operation and analysis, resonant switch ZVS converter, principle of operation and analysis, series resonant inverter, series resonant DC-DC converter, parallel resonant DC-DC converter, series- parallel L2,L3,L4,L5 resonant DC-DC converter, resonant converters comparison. Design of inductor and transformers for SMPC. TEXT 1 and TEXT 2. Reference 2 | Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|--|------------|---|----------------|-----------------------------|
| | 5 | principle of operation and analysis, resonant switch ZVS converter, principle of operation and analysis, series resonant inverter, series resonant DC-DC converter, parallel resonant DC-DC converter, series- parallel resonant DC-DC converter, resonant converters comparison. Design of inductor and transformers for SMPC. | 8 | L2,L3,L4,L5 |

Note 1: Unit 1 to 5 will have internal choice

Note2: Student has to submit one assignment per unit and is evaluated for 10 marks and group activity for 5 marks and Seminar for 5 Marks

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 Explain operating principle of various converters.
- CO2 Design transformer and inductor for Dc-DC converter.
- CO3 Analyze and distinguish different power converters.
- CO4 Design different power converters.
- CO5 Solve problems on different power converters.

Course Outcomes Mapping with Programme Outcomes.

| | Course | Level of | No. of hours | Programme Outcome | | | | | | | | | | |
|-------|------------|--------------------|--------------|-------------------|---|---|---|---|---|---|---|---|----|----|
| S1.No | Outcome | Blooms Taxonomy | of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1 | L1, L2 | 8 | 3 | 1 | 1 | | | | | | | | |
| 2. | CO2 | L2, L4 | 7 | | 1 | 3 | | | | | | | | |
| 3. | CO3 | L2,L4 | 8 | | 3 | 1 | 1 | | | | | | | |
| 4. | CO4 | L2,L4 | 8 | | 1 | 3 | 1 | | | | | | | |
| 5. | CO5 | L2,L3 | 8 | | 1 | 3 | | | | | | | | |
| | Average CO | | | | | | 1 | | | | | | | |

Course Outcomes Mapping with Programme Specific Outcomes

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

Text Books.

- 1 Daniel W Hart "Power Electronics", First Edition, Tata McGraw Hill, 2011
- 2 Rashid M.H, "Power Electronics Circuits Devices and Applications", 3rd Edition, Pearson, 2011.

Reference Text Books.

- 1 D M Mitchel "DC-DC Switching Regulator Analysis -", 1st edition, McGraw-Hill Ltd. 1988
- 2 Umanand L and Bhatt S R, "Design of Magnetic Components for Switched Mode Power Converters", 1 st edition, New Age International 2001
- 3 Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd edition, Wiley India Pvt. Ltd2010

- ¹ Prof. B. G. Fernandes" A course on Power Electronics" <u>http://nptel.ac.in/courses/108101038/</u>
- Prof. V. Ramnarayan/Prof. L. Umanand "A course on Switched Mode Power Conversion") <u>http://nptel.ac.in/courses/1081080363</u> Prof. K. Gopakumar "A course on Industrial Drives – Power Electronics"

Subject Title : POWER ELECTRONICS SYSTEM DESIGN USING LINEAR ICs

Sub.Code:20EPE23

No. of Credits:03=03:0:0 (L - T - P)

No. of Lecture Hours/Week : 03

Exam Duration:03 Hrs

CIE+Asmt+SS+GA+SEE=30+10+05+05+50=100

Total No.of Contact Hours:39

Course Learning Objectives:

- 1 Understand basic requirements of designing, measurement & protection circuits for power electronics systems using ICs.
- 2 Analyze various PWM ICs for controlling power electronics systems.
- 3 To analyze and distinguish different A/D and D/A converter circuits using ICs.
- 4 To design different power converters gating circuits using ICs.
- 5 To understand and program using PLC for power converters control.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. | | | | | |
|------------|---|----------------|-----------------------------|--|--|--|--|--|
| 1 | Introduction: Measurement techniques for voltages, current, power, power factor in power electronic circuits, sensing of speed. TEXT 1 and Text 2 | 7 | L1,L2 | | | | | |
| 2 | Switching Regulator Control Circuits: Introduction, isolation techniques of switching regulator systems, PWM systems. TEXT 1 and Text 2 | 7 | L2,L3 | | | | | |
| 3 | Commercial PWM Control ICs and their Applications: TL 494 PWM control IC, UC 1840 programmable off line PWM controller, UC 1860 resonant mode power supply controller. Switching power supply ancillary, supervisory & peripheral circuits and components: introduction, opto couplers, self-biased techniques used in primary side of reference power supplies, soft/start in switching power supplies. TEXT 1 and TEXT 2.Reference Book 2 | 9 | L3,L4 | | | | | |
| 4 | Protection of Switching power supply systems: current limit circuits, over voltage protection, AC line loss detection. Phase – Locked Loops (PLL) & Applications: PLL Design using IC:, 555 timer & its applications, analog to digital converter using IC's, digital to analog converters using ICs, implementation of different gating circuits. TEXT 1 and TEXT 2. Reference Book 3 | 8 | L2,L3,L4 | | | | | |
| 5 | Programmable Logic Controllers (PLC): Basic configuration of a PLC, power converter control using PLC,IC for Switch-Mode Power Supplies: Control IC for Switch mode power supplies, IC timers as controllers for switch-mode power supplies. TEXT 1 and TEXT 2. Reference 2 | 8 | L2,L3,L4 | | | | | |
| Note | Note 1: Unit 1 to 5 will have internal choice | | | | | | | |
| Noto | Nota?. Student has to submit one assignment per unit and is evaluated for 10 marks and | | | | | | | |

Note2: Student has to submit one assignment per unit and is evaluated for 10 marks and group activity for 5 marks and Seminar for 5 Marks

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

Course Outcomes:

CO1 Identify different measuring instruments required in Power Electronics circuits.

- CO2 Explain different methods of protection & isolation required in Power Electronics circuits.
- CO3 Justify different ICs available for PWM generation in Power converters.
- CO4 Understand PLC programming & implement gating circuits for power converters.

CO5 Analyse different switching power supply protection circuit.

Course Outcomes Mapping with Programme Outcomes.

| | | Lev | No. | | Programme Outcome | | | | | | | | | |
|-----------|---------------------------|--|---|---|-------------------|---|---|---|---|---|---|---|----|----|
| Sl. No | Cour se Outc ome | el of Blo oms Tax ono my | of hou rs of tea chi ng | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1 | 2 | 7 | | 3 | 1 | 2 | | | | 2 | | 2 | |
| 2. | CO2 | 2 | 7 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| 3. | CO3 | 2 | 9 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| 4. | CO4 | 4 | 8 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |
| 5. | CO5 | 5 | 8 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | |
| | Averag | ge Cos | | 3 | 3 | 1 | 2 | | | | 2 | | 2 | 2 |

Course Outcomes Mapping with Programme Outcomes.

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

Text Books.

- 1 G. K. Dubey, S. R. Doradla, A. Joshi, and R. M. K. Sinha, Thyristorised Power Controllers, 2nd Edition, New Age International, 2010.
- 2 Ned Mohan, Tore M. Undeland, William P. Robbins ,"Power Electronics Converters, Applications, and Design ", 3rd Edition, Wiley India Pvt. Ltd ,2010 .

Reference Text Books.

- 1 Unitrode application notes: http://www.smps.us/Unitrode.html
- 2 Switch- Mode Power Supply Design, P.R.K. Chetty, BPB Publications
- 3 Chryssis,, "High Frequency Switching Power Supplies", 2nd edition, MGH1989

- 1 Prof. L Umanand , Design and Simulation of Power conversion using open source tools, | IISc Bangalore
- 2 Prof. L Umanand, PV module in SPICE Videos | View ENGGtalks, IISc Bangalore
- 3 Abhijt Kshirsagar, Simulation toolkit using gEDA and ngSPICE for Digital Controller Design Course, IIT, Dharwad

Subject Title : HVDC POWER TRANSMISSION

| Sub.Code:20EPE24 | No. of Credits: $03=03:0:0 (L - T - P)$ | No. of Lecture Hours/Week : 03 |
|----------------------|---|--------------------------------|
| Exam Duration:03 Hrs | CIE+Asmt+SS+GA+SEE=30+10+05+05+50=100 | Total No.of Contact Hours:39 |

Course Learning Objectives:

- 1 To give an introduction to DC power transmission and describe the basic components of a converter.
- 2 To describe the methods for compensating the reactive power demanded by the converter and the methods for simulation of HVDC systems
- 3 To describe the types of filters for removing harmonics and the characteristics of the system impedance resulting from AC filter designs and different methods of control of HVDC converter and system.
- 4 To explain the design techniques for the main components of an HVDC system.
- 5 To explain the protection of HVDC system and other converter configurations used for the HVDC transmission and the recent trends for HVDC applications.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|---|----------------|-----------------------------|
| 1 | 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. TEXT 1 and Text 2 | 8 | L2, L3,L4 |
| 2 | Harmonics of HVDC and Removal: Introduction, Determination of Resulting Harmonic Impedance, Active Power Filter. Control of HVDC Converter and System: Converter Control for an HVDC System, Commutation Failure TEXT 1 and Text 2 | 8 | L2,L3,L4 |
| 3 | Control of HVDC Converter and System (continued): HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability. Interactions between AC and DC Systems: Definition of Short Circuit Ratio and Effective Short Circuit Ratio. | 8 | L2,L3 |
| 4 | Main Circuit Design: Converter Circuit and Components, Converter Transformer, Cooling System, HVDC Overhead Line, HVDC Earth Electrodes, HVDC Cable, HVDC Telecommunications Current Sensors, HVDC Noise and Vibration. TEXT 1 and TEXT 2. Reference Book 3 | 8 | L2,L3 |
| 5 | Fault Behaviour and Protection of HVDC System: Valve Protection Functions, Protective Action of an HVDC System, Protection by Control Actions, Fault Analysis. Other Converter Configurations for HVDC Transmission: Introduction, Voltage Source Converter (VSC), CCC and CSCC HVDC System, 10.4 Multi-Terminal DC Transmission. | 7 | L2,L3,L4 |

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. | | | | | |
|------------|--|----------------|-----------------------------|--|--|--|--|--|
| | Trends for HVDC Applications: Wind Farm Technology, Modern Voltage | | | | | | | |
| | | | | | | | | |
| | TEXT 1 and TEXT 2. Reference 3 | | | | | | | |
| | Unit 1 to 5 will have internal choice | | | | | | | |

Note 1:

Unit 1 to 5 will have internal choice

- Note2: Student has to submit one assignment per unit and is evaluated for 10 marks and group activity for 5 marks and Seminar for 5 Marks
- Out of 5 Units, Unit1is a Webinar unit conducted through Google Classroom/Zoom/Cisco Note:3 Webex etc and will be delivered by subject faculty.

Course Outcomes:

- CO1 Explain the importance of DC power transmission, the basic components of a converter and methods for compensating the reactive power.
- CO2 Explain the methods for simulation of HVDC systems and its control.
- CO3 Design filters for eliminating harmonics.
- CO4 Explain the design techniques for the main components of an HVDC system.
- CO5 Analyse the protection of HVDC system and other converter configurations used for the HVDC transmission and recent trends for HVDC applications.

Course Outcomes Mapping with Programme Outcomes.

| S1.No | Course | Course Level of Blooms | No. of hours | Programme Outcome | | | | | | | | | | |
|--------|------------|------------------------|--------------|-------------------|---|---|---|---|---|---|---|---|----|----|
| 51.140 | Outcome | Taxonomy | of teaching | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1. | CO1: | L1,L2 | 8 | | 3 | 1 | 2 | | | | 2 | | 2 | |
| 2. | CO2 | L1,L2 | 8 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | |
| 3. | CO3 | L2,L3 | 8 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | |
| 4. | CO4 | L1,L2 | 8 | 3 | 3 | 1 | 2 | | | | 2 | | 2 | |
| 5. | CO5 | L3,L4 | 7 | 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 | 3 | | |
| CO2 | 3 | | |
| CO3 | 2 | 2 | |
| CO4 | 3 | | |
| C05 | 2 | 2 | |
| Average CO | 3 | 2 | |

Text Books.

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

Reference Text Books.

- 1 K. R. Padiyar, "HVDC Power Transmission Systems", New Age International, 2012.
- 2 E.W.Kimbark "Direct Current Transmission", Vol.1, Wiley Inter-Science, London, 2006
- 3 Arrilaga, "High Voltage Direct Current Transmission", the Institute of Engineering and Technology, 2ndEdition, 2007.

Vijay K Sood, "HVDC and FACTs Controllers; Applications of Static Converters in Power Systems, BSP Books Pvt. Ltd., First Indian reprint 2013.

Web Links.

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

Subject Title : DSP APPLICATIONS TO DRIVES

| Sub.Code: 20EPE263 | No. of Credits: $03=03:0:0 (L - T - P)$ | No. of Lecture Hours/Week : 03 |
|----------------------|---|--------------------------------|
| Exam Duration:03 Hrs | CIE+Asmt+SS+GA+SEE=30+10+5+5+50=100 | Total No.of Contact Hours:39 |

Course Learning Objectives:

- 1 DSP controller, CPU architecture and instruction set
- 2 DSP-Based Applications
- 3 DSP-based control of permanent magnet brushless DC machines.
- 4 DSP-based vector control of permanent magnet synchronous motors.
- 5 DSP-based vector control of Induction motors.

| Unit No | Syllabus Contents | No.of Hours | Blooms Taxnomy level. |
|------------|--|----------------|-----------------------------|
| 1 | Introduction: To the TMS320LF2407 DSP Controller, DSP CPU architecture and instruction set. General Purpose Input/output (GPIO) functionality interrupts on the TMS320LF2407. Programming using Mat Lab. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 2 | Analog-to-Digital Converter (ADC), event managers (EVA, EVB). DSP-Based Applications: Of DC-DC buck-boost converters, DSP based control of stepper motors. TEXT 1 and TEXT 2. Reference Book 2 | 08 | L1,L2,L3. |
| 3 | DSP-Based control of permanent magnet brushless DC machines, Park and Clarke transformations. TEXT 1 and TEXT 2. Reference Book 1 | 08 | L1,L2,L3. |
| 4 | Space Vector Pulse Width Modulation, DSP-based control of permanent magnet synchronous machines. TEXT 1 and TEXT 2. Reference Book 2 | 08 | L1,L2,L3. |
| 5 | DSP-based vector control of induction motors TEXT 1 and TEXT 2. Reference Book 2 | 07 | L1,L2,L3. |

Note 1: Unit 1 to 5 will have internal choice

Note2: Student has to submit one assignment per unit and is evaluated for 10 marks and group activity for 5 marks and Seminar for 5 Marks

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

Course Outcomes:

- CO1 Explain DSP controller, CPU architecture and to write instruction set for specific task.
- CO2 Implement DSP for specific Applications.

CO3 Apply the transformation for machine modelling

- CO4 Implement DSP-based vector control of permanent magnet synchronous machine.
- CO5 Implement DSP-based vector control of induction motors.

Course Outcomes Mapping with Programme Outcomes.

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

Text Books.

- 1 Hamid Toliyat and Steven Campbell, "DSP-Based Electromechanical Motion Control CRC press", 2011
- 2 P.C.Krause, Oleg Wasynczuk, Scott D. Sudhoff, , "Analysis of Electrical Machinery and Drive Systems ", 2nd edition, Wiley India, 2010
- 3 Chee-Mun Ong , "Dynamic Simulation of Electric Machinery using Matlab / Simulink ", Prentice Hall, 1998

Reference Text Books.

- 1 Hugo Guzman, Mario Bermudez, Cristina Martin, Federic Barrero and Mario Duran, Intechopen.com, , "Application of DSP inPower Conversion Systems—A Practical Approach for Multiphase Drives 2015".
- 2 A Nagoor Kani, "Digital Signal Processing, 2 edition, McGraw Hill, 2013.

Web Links.

- 1 https://www.researchgate.net/publication/261235058_DSP_implementation_of_electric_drive_control_syste m
- 2 https://www.intechopen.com/books/applications-of-digital-signal-processing-through-practicalapproach/application-of-dsp-in-power-conversion-systems-a-practical-approach-for-multiphase-drives
- 3 https://www.analog.com/en/analog-dialogue/articles/dsp-based-control-for-ac-machines.html



Panchajanya Vidya Peetha Welfare Trust (Regd)

Dr. Ambedkar Institute of Technology

Aided by Govt. of Karnataka, An Autonomous Institution, Affiliated to Visvesvaraya Technological University, Belagaví, 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 : 0.5.01.2023

2019-20

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

| SI | Subject Code | Subject title | Mapped to |
|-----|--------------|--|----------------------------------|
| No | | | Employability/Entrepreneur/Skill |
| 1. | 18EPE12 | Power Semiconductor Devices and Components | Employability |
| 2. | 18EPE13 | Solid State Power Controllers | Employability |
| 3. | 18EPE14 | Modelling and Simulation of Power Electronics Systems | Entrepreneur |
| 4. | 18EPE151 | Embedded Systems | Skill |
| 5. | 18EPE152 | Advanced Control Systems | Skill |
| 6. | 18EPEL16 | Power Electronics Laboratory-1 | Skill |
| 7. | 18EPE21 | AC and DC Drives | Skill |
| 8. | 18EPE22 | Switched Mode Power Conversion | Employability |
| 9. | 18EPE23 | Power Electronics System Design Using Linear ICs | Skill |
| 10. | 18EPE253 | Electric Vehicle Technology | Entrepreneur |
| 11. | 18EPE41 | HVDC power Transmission | Employability |
| 12. | 18EPE421 | MPPT in solar systems | Employability |
| 13. | 18EPE422 | PWM converters and applications | Employability |
| 14. | 18EPE423 | DSP applications to drives | Skill |

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Subject title : POWER SEMICONDUCTOR DEVICES AND COMPONENTSSubject Code: 18EPE12No. of Credits : 3:0:0:0No. of lecture hours/week : 4Exam Duration : 3 hoursCIE : 50SEE : 50Total No. of lecture hours: 52

Course objective: In this course, student learn

1. Working of various power semiconductor devices.

- 2. Analyzing the switching parameters to decide the suitability of application.
- 3. Modeling and simulation of devices along with protection system.

| Unit No. | Syllabus content | No. of hours |
|-------------|--|--------------------|
| 1 | Basic Semiconductor Physics: Introduction, conduction processes in semiconductors pn junctions, charge control description of pn-junction operation, avalanche breakdown. Power Diodes: Introduction, Basic structure and I-V characteristics, breakdown voltage considerations, on – state losses, switching characteristics, schottky diodes. | 10 |
| 2 | Bipolar Junction Transistors: Introduction, vertical power transistor structures, I-V characteristics, physics of BJT operation, switching characteristics, breakdown voltages, second breakdown, on-state losses and safe operating areas. Power MOSFETs: Introduction, Basic structure, I-V characteristics, physics of device operation, switching characteristics, operating limitations and safe operating areas. | 12 |
| 3 | Thyristors: Introduction, basic structure, I-V characteristics, physics of device operation, switching characteristics, methods of improving di/dt and dv/dt ratings. Gate Turn-Off Thyristors: Introduction, basic structure and I-V characteristics, physics of turn-off operation, GTO switching characteristics, over current protection of GTOs. Insulated Gate Bipolar Transistors: Introduction, basic structure, I-V characteristics, physics of device operation, latch up in IGBTs, switching characteristics, device limits and SOAs. | 10 |
| 4 | Emerging Devices and Circuits: Introduction, power junction field effect transistors, field-controlled thyristor, JFET-based devices versus other power devices, MOS-controlled thyristors, power integrated circuits, new semiconductor materials for power devices. Snubber Circuits: Function and types of snubber circuits, diode snubbers, snubber circuits for thyristors, need for snubbers with transistors, turn-off snubber, overvoltage snubber, turn-on snubber, snubbers for bridge circuit configurations, GTO | 10 |

| | snubber considerations. | |
|------|--|-----------------|
| | Component Temperature Control and Heat Sinks: Control of semiconductor device temperatures, heat transfer by conduction, heat sinks, heat transfer by radiation and convection. | |
| 5 | Design of Magnetic Components: magnetic materials and cores, copper windings, thermal considerations, analysis of a specific inductor design, inductor design procedures, analysis of a specific transformer design, eddy currents, transformer leakage inductance, transformer design procedure, comparison of transformer and inductor sizes. | 10 |
| | Course outcome: At the end of the course, students will be able to | |
| | CO 1: Understand the working of various power semiconductor devicesCO2: Analyze the switching parameters to decide the suitability of application.CO3: Modeling and simulation of devices along with protection system | |
| | BOOKS: Power Electronics Converters, Applications, and Design- Ned Mohan et al, Wiley, Edition, 2014 | 3 rd |
| | CRENCE BOOKS: | |
| REFF | | |
| | Power Electronics - Daniel W Hart, McGraw Hill | |

Unit 3.

| Contraction of the | N OF HORE | Subject title | : Solid State | Power Contr | rollers | | |
|---------------------------|---------------------------------|---|---|---|---|--------------------|--|
| | | Subject Code: 18EPE13 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week | : 4 | |
| Autor By Card | of Kamataka | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | : 52 | |
| Cour | se ob | jective: In this course, studer | nt learn | 1 | l | | |
| 1. | Ana | alyzing various operating mod | les of differen | t power conve | erters. | | |
| 2. | | igning various AC/ DC powe | | | | | |
| 3. | Des | igning of control circuits for | power convert | ers using diffe | erent methods. | | |
| Unit No. | | | Syllabus co | ontent | | No. of hours | |
| 1 | cont | Line Commutated Converters: Phase control, single phase semi-converter & fully controlled converter, three phase semi controlled & fully controlled converter, dual converters, power factor improvement methods, effect of source inductance, single phase series converters, twelve pulse converter and design of converter circuits | | | | | |
| 2 | | Inverters: Principle of operation, performance parameters, single phase bridge inverters and three phase inverters. | | | | | |
| 3 | SPV PW | tage Control of Single Pha WM methods, voltage cont M/space vector modulation parison between VSI & CSI. | rol of three on, harmonic | phase inverte | er, SPWM/third harmonic | 10 | |
| 4 | | Itilevel Inverters: Introducti pplications. | on, types, dioc | le clamped mu | ulti-level inverters, features | 08 | |
| 5 | control | -DC Converters: Principle verters, , Push – Pull (Syn tinuous mode, output chan nilton circuit, Ćuk converters | mmetric) conv acteristics, h | verters - analy | ysis of idealized circuit in | 10 | |
| | Cou | urse outcome: At the end of | the course, stu | dents will be a | able to | | |
| | CO | Analyze various operating Design various power con Design control circuits for | verters. | | | | |
| 1. P W 2. P 3. N | ower Villian Ower Mode | OKS/ REFERENCE BOOI • Electronics Converters, A m P. Robbins, 3 rd Edition,Wild • Electronics: Circuits Devic rn Power Electronics & AC | Applications, ey India Pvt. L es and Applic Drives- B. K | td, 2011 2 ations -Rashio . Bose PHI, 20 | d M.H 3 rd Edition, Pearson, 2 012. | 011. | |
| Note | e: Une | e question of 20 marks from | each unit. In Unit : | | es must de provided in Unit | I and | |

| A CONTRACTOR OF THE OWNER | Subject title : MODELING AND SIMULATION FOR POWER ELECTRONICS SYSTEMS | | | | | | | | |
|-----------------------------|--|--------------------------|----------|-----------------------------|----|--|--|--|--|
| | Subject Code: 18EPE14 | No. of Credits : 3:0:0:0 | | No. of lecture hours/week : | 4 | | | | |
| Added By Caret, of Ramabaka | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours: | 52 | | | | |

Course objective: In this course, student learn

- 1. Types of modeling applicable o power electronics
- 2. Types and need for control system
- 3. Control system design for converters

4. To analyze a system and to make use of the information to improve the performance.

| Unit No. | Syllabus content | No. of hours |
|-------------|--|--------------------|
| 1 | Computer Simulation of Power Electronic Converters and Systems: introduction, challenges in computer simulation, simulation process, mechanics of simulation, solution techniques for time-domain analysis, widely used, circuit-oriented simulators, equation solvers. Modeling of Systems: input-output relations, differential equations and linearization, state space representation, transfer function representation, block diagrams, lagrange method, circuit averaging, bond graphs, space vector modeling | 12 |
| 2 | Control System Essentials: control system basics, control principles, state - space method, bode diagram method, root locus method, state space method | 10 |
| 3 | Digital Controller Design: controller design techniques, , pid controller, , full state feedback, regulator design by pole placement, estimation design, tracker : controller design | 10 |
| 4 | Digital Controller Design (Continued): controlling voltage, controlling current, control of induction motor, output feedback, induction motor control with output feedback. Optimal and Robust Controller Design: least squares principle, quadratic forms, minimum energy principle, least square solution, weighted least squares, recursive least squares, optimal control: linear quadratic, induction motor example, robust controller design. | 12 |
| 5 | Discrete Computation Essentials: numeric formats, tracking the base point in the fixed point system, normalization and scaling, arithmetic algorithms | 08 |
| | Course outcome: At the end of the course, students will be able to CO 1: Understand the system concept and apply functional modeling method to model the activities of a static system CO2: Understand the behavior of a dynamic system and create an analogous model for a dynamic system CO3: Simulate the operation of a dynamic system and make improvement according to the simulation results | |

TEXT BOOKS/ REFERENCE BOOKS:

- 1. **Power Electronics Converters, Applications, and Design** Ned Mohan, Wiley, 3rdEdition,2014
- 2. **Power Electronics Essentials and Applications** L. Umanand, Wiley, 1st Edition, 2014

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 1 and Unit 4.

| Carlos Trut | S Ilon | Subject title | : EMBEDDE | ED SYSTEM | 8 | | | |
|----------------------|---|---|---|--|---|--------------------|--|--|
| | | Subject Code: 18EPE151 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week | :: 4 | | |
| A set filled | | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | s: 52 | | |
| 1. 2. 3. 4. | the o emb the i | jective: In this course, student concepts of embedded system bedded system architecture and interprocess communication, to isation of real time operating s | d memory org modeling, dev | | munication buses. | | | |
| Unit No. | | | Syllabus co | ntent | | No. of hours | | |
| 1 | syst syst VLS proc | Introduction to Embedded Systems: embedded systems, processor embedded into a system, embedded hardware units and devices in a system, embedded software in a system, examples of embedded systems, embedded systems – on –chip (soc) and use of VLSI circuit design technology, complex systems design and processors, design of process in embedded system, formulation of system design, design process and design examples, classification of embedded systems, skill required for an embedded system designer. | | | | | | |
| 2 | Processor Architecture and Memory Organisation: 8051 architecture, real world interfacing, introduction to advanced architecture, processor and memory organization, instruction level parallelism, performance metrics, memory – types, memory – maps and addresses, processor selection, memory selection. | | | | | 12 | | |
| 3 | seria devi cloc com Dev appr | rices and Communication Bu al communication devices, par- ice ports, wireless devices, tin ek, networked embedded syste munication network using IS. Fice Drivers and Interrupts S roach without interrupt service ricing mechanism, direct mem | rallel device p ner and counti ms, serial bus A,PCI, PCI –2 Service Mecha e mechanism, | orts, sophistic ng devices, w device protoc X and advance anisms: Prog | cated interfacing features in atchdog timer, real time cols – parallel ed protocols. rammed – I/O busy – wait | 10 | | |
| 4 | prog Inte Tas task their sign | gram Modeling Concepts: If gramming models for event – erprocess Communication and ks: multiple processes in an a status, task and data, clear – r characteristics, concept of se al function, semaphore function ctions, socket functions, RPC | controlled pro nd Synchroni pplication, mu cut distention emaphores, sha ons, message | gram flow. zation of Pro ultiple threads between func ared data, inte | ccesses, Threads and in an application, tasks, tions, ISRS and tasks by erprocess communication, | 10 | | |
| 5 | | I-Time Operating Systems: nt functions, memory manage | | • | 0 | 10 | | |

| interrupt routines in RTOS environment and handling of interrupt source calls, real – time operating systems, basic design using an RTOS, RTOS task scheduling models, interrupt latency and response of the task as performance metrics, OS security issues. | |
|---|-------------|
| Course outcomes: | |
| At the end of the course the student will be able to: | |
| 1. Understand the concept of embedded system. | |
| 2. Analyse the embedded system architecture and memory organization. | |
| 3. Analyse the real time system ARM processor. | |
| 4. Realise real time operating system. | |
| TEXT BOOKS/ REFERENCE BOOKS | |
| 1. Embedded Systems: Architecture, Programming and Design, Raj Kamal, McGraw Hill | $1, 2^{nd}$ |
| Edition,2014 | |
| Note: One question of 20 marks from each unit. Internal Choices must be provided in Uni | t 3 and |
| Unit 5. | |

| Sale Mannun | Sido | Subject title | : ADVANCE | D CONTRO | L SYSTEMS | |
|----------------|--|---|---|--|---|--------------------------|
| | | Subject Code: 18EPE152 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week | : 4 |
| | | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | s: 52 |
| 1. Th 2. Th | ie non ie Opt ie Mou Digi Con Basi z – ' Plar | jective: In this course, studen linear systems and Digital Co imization of the control parar deling of Digital Control System figurations of the Basic Digit ic Discrete – Time Signals, T Fransform, Transfer Function and Jury Stability Criterion sing, Reconstruction of Anal | ontrol Systems neters using d ems. Syllabus co Terminology al Control Sch ime Domain M Models, Freq , Sample and | ifferent optim ntent 7, Need of Dig neme, Principl Models for Dis uency Respor Hold Systems | ital control, e of Signal Conversion, crete – Time Systems, The use, Stability on the z – , Sampled Spectra and | No. of hours 10 |
| 2 | Sam Mo Des with | Aliasing, Reconstruction of Analog Signals, Practical Aspects of the choice of Sampling Rate, Principle of Discretization. Models of Digital Control Devices and Systems: Introduction, z – Domain Description of Sampled Continuous – time Plants, z – Domain Description of Samples with Dead – Time, Implementation of Digital Controllers, Tunable PID Controllers, Digital Temperature and Position Control Systems, Stepping Motors and their Control. | | | | 10 |
| 3 | of Des Des Con Pole Stat Stat Sepa Feed | The Variable Analysis of Digit Digital Processors, State Description of Systems with Dead trollability and Observability. Placement Design and Stat e Feedback, Necessary and su e Regulator Design, Design of aration Principle, Servo Desig diforward Control, State Feedback a State Feedback, Deadbeat co | iption of Sam d Time, Soluti , Multivariable te Observers: afficient Cond f State Observ gn – Introduction pack with Inte | pled continuo on of State Di e Systems. Introduction, itions for Arbi yers, Compens ion of the refe gral Control, I | us – Time Plants, State fference Equations, Stability Improvement by itrary Pole – Placement, ator Design by the rence Input by Digital Control Systems | 12 |
| 4 | Lya Prot | adratic Optimal Control: punov Functions for Linear S plems, Quadratic Performan ulator, Optimal Digital Contr | Systems, Paran nce Index, C | meter Optimiz Control Conf | igurations, Optimal State | 10 |
| 5 | Con Des | linear System Analysis: In nmon nonlinearities in Con cribing Function of Common ction Method, Concept of Ph | ntrol Systems n nonlinearitie | s, Describing es, Stability A | Function Fundamentals, analysis by the Describing | 10 |

System Analysis on the Phase Plane, Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems

Course outcomes:

At the end of the course the student will be able to:

- 1. Analyse the nonlinear systems and Digital Control Systems
- 2. Optimize the control parameters using different optimization techniques.
- 3. Model Digital Control Systems.

TEXT BOOKS

1. Digital Control and State Variable Methods (Conventional and Intelligent Control Systems) M Gopal, McGraw Hill, 3rdEdition,2008.

REFERENCE BOOKS

- 1. Discrete Time Control Systems, Katsuhiko Ogata.
- 2. Digital Control Systems, Benjamin C Kuo, Oxford University Press, 2nd Edition, 2007.

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 3 and Unit 5.

| STATUTE C | 215 | Subject title | Subject title : POWER ELECTRONICS LABORATORY-I | | | | | |
|-------------------|--|--|--|----------------|-------------------------------|----------|--|--|
| | | Subject Code: 18EPEL16 | No. of Cred | its : 2:0:0:0 | No. of lecture hours/week | : 3 | | |
| Aided By Gavt. of | Ramataka | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | : 39 | | |
| Cours | se obj | jective: In this course, student | t learn | I | | | | |
| 1. | Th | e application of appropriate te | chniques to so | olve power ele | ectronics problem using mode | ern | | |
| | too | •• •• • | 1 | 1 | | | | |
| 2. | | e working collaboratively on | - | • | | | | |
| 3. | Th | e computation of the perform | ance of vario | us converters. | | | | |
| Unit No | Unit No. Syllabus content | | | | | | | |
| 1 | Ana | Analysis of static and dynamic characteristic of MOSFET and IGBT | | | | | | |
| 1 | | | | | | | | |
| 2 | | formance of single phase ful inuous current mode. | ly controlled | and semi-con | ntrolled converter for RL lo | oad for | | |
| 3 | | ormance of single phase ful ontinuous current mode. | ly controlled | and semi-con | ntrolled converter for RL lo | oad for | | |
| 4 | | ly of effect of source indu- verter. | ctance on the | e performance | e of single phase fully cor | ıtrolled | | |
| 5 | | ormance analysis of three ph continuous current mode. | ase fully cont | rolled and ser | ni-controlled converter for R | L load | | |
| 6 | | ormance analysis of three ph liscontinuous current mode. | ase fully cont | rolled and ser | ni-controlled converter for R | L load | | |
| 7 | | ormance analysis of single particular of single particular of single particular of single particular of the second | hase bridge ir | verter for RL | load and voltage control by | ' single | | |
| 8 | Perf | ormance analysis of two quac | lrant chopper. | | | | | |
| 9 | Diode clamped multilevel inverter. | | | | | | | |
| 10 | ZVS operation of a synchronous buck converter. | | | | | | | |
| | Cou | irse outcomes: | | | | | | |
| | At t | he end of the course the stude | nt will be able | e to: | | | | |
| | | 1. Apply appropriate technic tools. | ques to solve j | power electron | nics problem using modern | | | |
| | | 2. Work collaboratively on | multidisciplin | ary environme | ent. | | | |

| CARA MATTURE O | 109 | Subject title | AC AND D | C DRIVES | | |
|---|--|---|---|---|---|-----------------|
| | | Subject Code: 18EPE21 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week | : 4 |
| | | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | : 52 |
| Course 1. 2. 3. Unit No. | Dif The | jective: In this course, student ferent Quadrant operation of Dri e concept of AC/DC variable fferent control methods of ele | ves speed drives. | | | No. of |
| 1 | Electric Drives : Introduction – block diagram-classification of electrical drives-choice of electrical drives-fundamental torque equation- components of load torque- steady state stability. | | | | hours 08 | |
| 2 | quad Two | Drives : Single Quadrant Driver drants Drive: 1-phase and 3-pi o and Four Quadrant drive: 1- sing methods and closed loop | hase full conv -phase and thi | verter drive. ree- phase dua | | 12 |
| 3 | oper – di | Drives : Voltage and current ration, Control of Induction rect and indirect vector control or drives, stator and rotor volt | on motor di rol, voltage a | rive -V/f and current so | d field oriented control urce inverter fed induction | 12 |
| 4 | Closed Loop Control of AC Drives : Basic principle of vector control, direct & indirect vector control of induction motor, stator voltage control, slip regulation, speed control of static Kramer's drive, closed loop control of synchronous motors. stepper motor. | | | 10 | | |
| 5 | | Dications of Drives: Drive control hoist drives and centrifugal p | | or textile mills | s, steel rolling mills, cranes | 10 |
| | CO CO2 | arse outcome: At the end of the first outcome: At the end of the first outcome is a second state of the second state | ledge of vario ge of different | us AC/DC dri quadrant oper | ves. | |
| 1. Po Pro 2. Th | Mo Ele Ele REN wer entico yrist | OKS: odern Power Electronics & A ectric Motor Drives - R Krishi ectric Drives-Concepts and Ap NCE BOOKS: Electronics- Circuits, Dev e Hall 2010. tor Control of AC Motors- N Performance Control of AC 1 | nan, PHI, 2010 oplications- Vo vices and A Murphy JMD, | edam Subrahma pplications - Turnbull F.G | nyam, McGraw Hill, 2 nd edition Muhammad H. Rashid, I ., Pergamon Press Oxford. 19 | Pearson 998. |
| Note: | One | e question of 20 marks from | each unit. In Unit (| | es must be provided in Unit | 2 and |

| Sta santun | O'HOMO | Subject title : SV | VITCHED MO | DE POWER CC | ONVERSION | |
|-------------------------|--|---|--|--|--|--------------------|
| Tra.s. | | Subject Code: 18EPE22 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week | : 4 |
| | | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | : 52 |
| Cours 1. 2. 3. | . Th . <mark>Th</mark> | ective: In this course, students e operating principles of diffe e Designing and controlling o e Simulation in computer for | rent power co f different pov | wer converters | | |
| Unit No. | | | Syllabus co | ontent | | No. of hours |
| 1 | switt oper volt cons oper ripp disc con | - DC Converters (Basic Control of the converter (SMPC), contraction and analysis of buck of age ripple, capacitor resistentions, buck converter ration and analysis of boost of the continuous current operation, verter analysis, inductors siderations for continuous current operation, siderations for continuous current operation, siderations for continuous current operations for coperations for continuous current operations for continuous current | omparison be converter ana istance effec for disconti converter, ind ect, design principle of current rippl | etween LVR lysis, inductor ct, synchrono nuous current ductor current consideration operation ar e and output | & SMPC, principle of r current ripple and output ous rectification, design at operation, principle of ripple and output voltage ons, boost converter for ad analysis of buck boost | 12 |
| 2 | anal resis con Der anal desi | k-boost converter for discon lysis of CUK converter, indu stance effect, design co verter(SEPIC). rived Converters : Introducti lysis of fly back converter-con ign considerations, principle of siderations. | ctor current r nsiderations, ion, transform ntinuous and | ipple and outp single end ner models, p discontinuous | out voltage ripple, capacitor led primary inductance principle of operation and current mode of operation, | 10 |
| 3 | Double ended (Two switch) forward converter, principle of operation and analysis of push-pull converter, design considerations, principle of operation and analysis of full bridge and half-bridge DC-DC converters, design considerations, current fed converters, multiple outputs | | | | 10 | |
| 4 | Con cont fund PSp desi | converters, multiple outputs. Control of DC-DC Converter: Modeling of DC-DC converters, power supply control, control loop stability, small signal analysis, switch transfer function, filter transfer function, PWM transfer function, Type-2 error amplifier with compensation, design, PSpice simulation of feedback control, Type-3 error amplifier with compensation, design. | | | | |
| 5 | oper anal DC- com | onant Converters: Introduc ration and analysis, resonan lysis, series resonant inverter -DC converter, series- paral parison, resonant DC link con ign of inductor and transfor | t switch ZVS , series reson llel resonant nverter. | S converter, j ant DC-DC c DC-DC conv | principle of operation and converter, parallel resonant | 10 |
| | CO CO | Trse outcome: At the end of the 1: Analyze and distinguish the 2: Design and control the different 3: Simulate in computer for R | e power conv ferent power c | erters onverters | | |

TEXT BOOKS:

- 1. **Power Electronics-** Daniel W Hart Tata McGraw Hil 1, 2011.
- 2. Power Electronics Circuits Devices and Applications -Rashid M.H., 3 rd Edition, Pearson, 2011.

REFERENCE BOOKS:

- 1. DC-DC Switching Regulator Analysis D M Mitchel M cGraw-Hill Ltd, 1988.
- 2. Design of Magnetic Compon ents for Switched Mode Power Converters- Umanand L and Bhatt S R New Age International, New Delhi, 2001
- **3.** Power Electronics Converters, Applications, and Design-Ned Mohan, Tore M. Undeland, William P. Robbins 3rd Edition, Wiley India Pvt Ltd, 2010.

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 1 and Unit 2.

| Autor By Govt. of Ramataka |
|----------------------------|

| Subject t | itle : POWE | R ELECTRO | NICS SYSTEM DESIGN |
|-------------------------|-------------|-----------------|--------------------------------|
| | USING LI | NEAR ICs | |
| Subject Code: 18EPE23 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week : 4 |
| Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours: 52 |

Course objective: To enable students learn

1. To explain basic and necessary requirements for designing a regulator circuit.

- 2. To discuss various types of PWM ICs used for designing regulator circuits.
- 3. To introduce and explain basics of PLC and programming of PLC.

| Unit No. | Syllabus content | No. of hours |
|---------------|---|--------------------|
| 1 | Introduction : Measurement techniques for voltages, current, power, power factor in power electronic circuits, other recording and analysis of waveforms, sensing of speed | 10 |
| 2 | Switching Regulator Control Circuits: Introduction, isolation techniques of switching regulator systems, PWM systems. | 10 |
| 3 | Commercial PWM Control ICs and their Applications: TL 494 PWM control IC, UC 1840 programmable off line PWM controller, UC 1524 PWM control IC, UC 1846 current mode control IC, UC 1860 resonant mode power supply controller. Switching power supply ancillary, supervisory & peripheral circuits and components: introduction, optocouplers, self-biased techniques used in primary side of reference power supplies, soft/start in switching power supplies. | 12 |
| 4 | Protection of Switching power supply systems: current limit circuits, over voltage protection, AC line loss detection. Phase – Locked Loops (PLL) & Applications: PLL Design using ICs, 555 timer & its applications, analog to digital converter using IC's, digital to analog converters using ICs, implementation of different gating circuits. Various ADC and DAC circuits. | 10 |
| 5 | Programmable Logic Controllers (PLC): Basic configuration of a PLC, programming and PLC, program modification, power converter control using PLCs. ICs for Switch-Mode Power Supplies: Control ICs for Switch mode power supplies, IC timers as controllers for switch-mode power supplies. | 10 |
| | Course outcome: At the end of the course, students will be able to CO 1: identify Types of measuring instruments required in PE circuits. CO 2: Detailed methods of protection & isolation requirements CO 3: Different ICs available for various purposes (PWM generation, protection etc). CO 4: Basics of PLC and basic programming methods of PLC | |
| TEX 1. | F BOOKS: "Thyristorised Power Controllers", G. K. Dubey, S. R. Doradla, A. Johsi, and R. M. K | Sinha |
| 1. | 2ndEdition, New Age International, 2010. | . Sillid, |
| 2. | | |
| 3. | Unitrode application notes: http://www.smps.us/Unitrode.html | |

REFERENCE BOOKS:

1. "Switch- Mode Power Supply Design", P.R.K. Chetty, BPB Publications.

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 3 and Unit 4.

| STANTIUTE O | 110mo | Subject title : El | LECTRIC V | EHICLE TE | CHNOLOGY | |
|----------------------|---|--|-------------------------|-----------------|-----------------------------|--------------------|
| | | Subject Code: 18EPE253 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week | : 4 |
| Anted By Gave, of Ko | anataka | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | : 52 |
| 1. A 2. V 3. C | dvar ariou hara | e objective: : In this course, st ntages of EVs. as drive trains cteristics of various types of b pt of hybrid electric vehicles | | | | |
| Unit No. | | | Syllabus co | ontent | | No. of hours |
| 1 | impa stan | oduction to electric vehicle acts. EV market and promo dardization. | tion: infrastr | ucture needs | legislation and regulation, | 10 |
| 1 | Electric vehicle (EV) design options: EV con figurations: fixed vs. variable gearing, single- vs. multiple-motor drive, in-wheel drives. EV parameters, driving cycles and performance specifications. Choice of system voltage levels: electrical safety and protection. | | | | | 10 |
| 2 | Vehicle dynamics and motor drives: Road load: vehicle kinetics; effect of velocity, acceleration and grade. EV drive train and components. EV motor drive systems: DC drives, induction motor drives, permanent-magnet synchronous motor drives, switched reluctance motor drives. Control strategies. | | | | 10 | |
| 3 | Batteries: Battery parameters. Types and characteristics of EV batteries. Battery testing and maintenance; charging schemes. Battery monitoring techniques. Open- circuit voltage and ampere- hour estimation. Battery load levelling | | | 10 | | |
| 4 | Emerging EV technologies: Hybrid electric vehicles (HEVs): types, operating modes, torque coordination and control, generator/motor requirements. | | | | 10 | |
| 5 | refo | l cell electric vehicles (FEVs rmers. Alternative sources of | power: super- | - and ultra- ca | pacitors, flywheels. | 10 |
| | | Irse outcome: At the end of the local section | | | able to | |
| | | 1: Describe the configuration 2: Differentiate among differe | • • | | | |
| | | 3: Understand the limitations | | | attery chemistries. | |
| | | 4: Develop strategies for char | | | | |
| ГЕХТ | | 5: Describe the various drive | trains of hybri | d electric vehi | icles. | |
| 1. 1. | Mo boi | odern Electric Vehicle Tech ndon ectric and Hybrid Vehicles: 1 | | | • | Press, |
| REFE 1. | Mo | ICE BOOKS: odern Electric, Hybrid Ele | | | | ry and |
| 2. | | sign- M. Ehsani, Y. Gao, S .E e b address - Batteryuniversity | - | Emadi, - New | York: CRC Press | |
| Note: | One | question of 20 marks from | each unit. In Unit (| | es must be provided in Unit | 1 and |



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

2018-19

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

| SI | Subject Code | Subject title | Mapped to |
|-----|--------------|--|----------------------------------|
| No | | | Employability/Entrepreneur/Skill |
| 1. | 18EPE12 | Power Semiconductor Devices and Components | Employability |
| 2. | 18EPE13 | Solid State Power Controllers | Employability |
| 3. | 18EPE14 | Modelling and Simulation of Power Electronics Systems | Entrepreneur |
| 4. | 18EPE151 | Embedded Systems | Skill |
| 5. | 18EPE152 | Advanced Control Systems | Skill |
| 6. | 18EPEL16 | Power Electronics Laboratory-1 | Skill |
| 7. | 18EPE21 | AC and DC Drives | Skill |
| 8. | 18EPE22 | Switched Mode Power Conversion | Employability |
| 9. | 18EPE23 | Power Electronics System Design Using Linear ICs | Skill |
| 10. | 18EPE253 | Electric Vehicle Technology | Entrepreneur |
| 11. | 18EPE41 | HVDC power Transmission | Employability |
| 12. | 18EPE421 | MPPT in solar systems | Employability |
| 13. | 18EPE422 | PWM converters and applications | Employability |
| 14. | 18EPE423 | DSP applications to drives | Skill |

Leeger el celu & BOS Chairman

Principal



Subject title : POWER SEMICONDUCTOR DEVICES AND COMPONENTSSubject Code: 18EPE12No. of Credits : 3:0:0:0No. of lecture hours/week : 4Exam Duration : 3 hoursCIE : 50SEE : 50Total No. of lecture hours: 52

Course objective: In this course, student learn

1. Working of various power semiconductor devices.

- 2. Analyzing the switching parameters to decide the suitability of application.
- 3. Modeling and simulation of devices along with protection system.

| Unit No. | Syllabus content | No. of hours |
|-------------|--|--------------------|
| 1 | Basic Semiconductor Physics: Introduction, conduction processes in semiconductors pn junctions, charge control description of pn-junction operation, avalanche breakdown. Power Diodes: Introduction, Basic structure and I-V characteristics, breakdown voltage considerations, on – state losses, switching characteristics, schottky diodes. | 10 |
| 2 | Bipolar Junction Transistors: Introduction, vertical power transistor structures, I-V characteristics, physics of BJT operation, switching characteristics, breakdown voltages, second breakdown, on-state losses and safe operating areas. Power MOSFETs: Introduction, Basic structure, I-V characteristics, physics of device operation, switching characteristics, operating limitations and safe operating areas. | 12 |
| 3 | Thyristors: Introduction, basic structure, I-V characteristics, physics of device operation, switching characteristics, methods of improving di/dt and dv/dt ratings. Gate Turn-Off Thyristors: Introduction, basic structure and I-V characteristics, physics of turn-off operation, GTO switching characteristics, over current protection of GTOs. Insulated Gate Bipolar Transistors: Introduction, basic structure, I-V characteristics, physics of device operation, latch up in IGBTs, switching characteristics, device limits and SOAs. | 10 |
| 4 | Emerging Devices and Circuits: Introduction, power junction field effect transistors, field-controlled thyristor, JFET-based devices versus other power devices, MOS-controlled thyristors, power integrated circuits, new semiconductor materials for power devices. Snubber Circuits: Function and types of snubber circuits, diode snubbers, snubber circuits for thyristors, need for snubbers with transistors, turn-off snubber, overvoltage snubber, turn-on snubber, snubbers for bridge circuit configurations, GTO | 10 |

| | snubber considerations. | |
|------|--|-----------------|
| | Component Temperature Control and Heat Sinks: Control of semiconductor device temperatures, heat transfer by conduction, heat sinks, heat transfer by radiation and convection. | |
| 5 | Design of Magnetic Components: magnetic materials and cores, copper windings, thermal considerations, analysis of a specific inductor design, inductor design procedures, analysis of a specific transformer design, eddy currents, transformer leakage inductance, transformer design procedure, comparison of transformer and inductor sizes. | 10 |
| | Course outcome: At the end of the course, students will be able to | |
| | CO 1: Understand the working of various power semiconductor devicesCO2: Analyze the switching parameters to decide the suitability of application.CO3: Modeling and simulation of devices along with protection system | |
| | BOOKS: Power Electronics Converters, Applications, and Design- Ned Mohan et al, Wiley, Edition, 2014 | 3 rd |
| | CRENCE BOOKS: | |
| REFF | | |
| | Power Electronics - Daniel W Hart, McGraw Hill | |

Unit 3.

| Contraction of the | N OF HORE | Subject title | : Solid State | Power Contr | rollers | |
|---------------------------|--|---|---|---|---|--------------------|
| | | Subject Code: 18EPE13 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week | : 4 |
| Autor By Card | of Kamataka | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | : 52 |
| Cour | se ob | jective: In this course, studer | nt learn | 1 | l | |
| 1. | Ana | alyzing various operating mod | les of different | t power conve | erters. | |
| 2. | | igning various AC/ DC powe | | | | |
| 3. | Des | igning of control circuits for | power convert | ers using diffe | erent methods. | |
| Unit No. | | | Syllabus co | ontent | | No. of hours |
| 1 | cont | Line Commutated Converters: Phase control, single phase semi-converter & fully controlled converter, three phase semi controlled & fully controlled converter, dual converters, power factor improvement methods, effect of source inductance, single phase series converters, twelve pulse converter and design of converter circuits | | | 14 | |
| 2 | | Inverters: Principle of operation, performance parameters, single phase bridge inverters and three phase inverters. | | | 10 | |
| 3 | SPV PW | Voltage Control of Single Phase Inverters: Single/multiple, pulse/SPWM/ modified SPWM methods, voltage control of three phase inverter, SPWM/third harmonic PWM/space vector modulation, harmonic reduction, current source inverter, comparison between VSI & CSI. | | | | 10 |
| 4 | Multilevel Inverters: Introduction, types, diode clamped multi-level inverters, features & applications. | | | | 08 | |
| 5 | control | -DC Converters: Principle verters, , Push – Pull (Syn tinuous mode, output chan nilton circuit, Ćuk converters | mmetric) conv acteristics, h | verters - analy | ysis of idealized circuit in | 10 |
| | Cou | urse outcome: At the end of | the course, stu | dents will be a | able to | |
| | CO | Analyze various operating Design various power con Design control circuits for | verters. | | | |
| 1. P W 2. P 3. N | ower Villian Ower Mode | OKS/ REFERENCE BOOI • Electronics Converters, A m P. Robbins, 3 rd Edition,Wild • Electronics: Circuits Devic rn Power Electronics & AC | Applications, ey India Pvt. L es and Applic Drives- B. K | td, 2011 2 ations -Rashio . Bose PHI, 20 | d M.H 3 rd Edition, Pearson, 2 012. | 011. |
| Note | e: Une | e question of 20 marks from | each unit. In Unit : | | es must de provided in Unit | I and |

| | Subject title : MODELI SYSTEMS | NG AND SIMULATION FOR POWER ELECTRONICS | | | | | |
|--|-----------------------------------|---|-----------------------------|-----------------------------|----|--|--|
| | Subject Code: 18EPE14 | No. of Cred | No. of lecture hours/week : | 4 | | | |
| | Exam Duration : 3 hours | CIE : 50 SEE : 50 | | Total No. of lecture hours: | 52 | | |

Course objective: In this course, student learn

- 1. Types of modeling applicable o power electronics
- 2. Types and need for control system
- 3. Control system design for converters

4. To analyze a system and to make use of the information to improve the performance.

| Unit No. | Syllabus content | No. of hours |
|-------------|--|--------------------|
| 1 | Computer Simulation of Power Electronic Converters and Systems: introduction, challenges in computer simulation, simulation process, mechanics of simulation, solution techniques for time-domain analysis, widely used, circuit-oriented simulators, equation solvers. Modeling of Systems: input-output relations, differential equations and linearization, state space representation, transfer function representation, block diagrams, lagrange method, circuit averaging, bond graphs, space vector modeling | 12 |
| 2 | Control System Essentials: control system basics, control principles, state - space method, bode diagram method, root locus method, state space method | 10 |
| 3 | Digital Controller Design: controller design techniques, , pid controller, , full state feedback, regulator design by pole placement, estimation design, tracker : controller design | 10 |
| 4 | Digital Controller Design (Continued): controlling voltage, controlling current, control of induction motor, output feedback, induction motor control with output feedback. Optimal and Robust Controller Design: least squares principle, quadratic forms, minimum energy principle, least square solution, weighted least squares, recursive least squares, optimal control: linear quadratic, induction motor example, robust controller design. | 12 |
| 5 | Discrete Computation Essentials: numeric formats, tracking the base point in the fixed point system, normalization and scaling, arithmetic algorithms | 08 |
| | Course outcome: At the end of the course, students will be able to CO 1: Understand the system concept and apply functional modeling method to model the activities of a static system CO2: Understand the behavior of a dynamic system and create an analogous model for a dynamic system CO3: Simulate the operation of a dynamic system and make improvement according to the simulation results | |

TEXT BOOKS/ REFERENCE BOOKS:

- 1. **Power Electronics Converters, Applications, and Design** Ned Mohan, Wiley, 3rdEdition,2014
- 2. **Power Electronics Essentials and Applications** L. Umanand, Wiley, 1st Edition, 2014

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 1 and Unit 4.

| Sala Mantura | Subject title : EMBEDDED SYSTEMS | | | | | | |
|----------------------|---|---|-------------------------------|---------------|----------------------------|--------------------|--|
| | | Subject Code: 18EPE151 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week | :: 4 | |
| A set filled | | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | s: 52 | |
| 1. 2. 3. 4. | the o emb the i | jective: In this course, student concepts of embedded system bedded system architecture and interprocess communication, to isation of real time operating s | d memory org modeling, dev | | munication buses. | | |
| Unit No. | | | Syllabus co | ntent | | No. of hours | |
| 1 | Introduction to Embedded Systems: embedded systems, processor embedded into a system, embedded hardware units and devices in a system, embedded software in a system, examples of embedded systems, embedded systems – on –chip (soc) and use of VLSI circuit design technology, complex systems design and processors, design of process in embedded system, formulation of system design, design process and design examples, classification of embedded systems, skill required for an embedded system designer. | | | | 10 | | |
| 2 | Processor Architecture and Memory Organisation: 8051 architecture, real world interfacing, introduction to advanced architecture, processor and memory organization, instruction level parallelism, performance metrics, memory – types, memory – maps and addresses, processor selection, memory selection. | | | | | 12 | |
| 3 | Devices and Communication Buses, Interrupt Services: IO types and examples, serial communication devices, parallel device ports, sophisticated interfacing features in device ports, wireless devices, timer and counting devices, watchdog timer, real time clock, networked embedded systems, serial bus device protocols – parallel communication network using ISA,PCI, PCI –X and advanced protocols. Device Drivers and Interrupts Service Mechanisms: Programmed – I/O busy – wait approach without interrupt service mechanism, ISR concept, interrupt sources, interrupt servicing mechanism, direct memory access. | | | | 10 | | |
| 4 | Program Modeling Concepts:Program models, DFG models, state machine programming models for event – controlled program flow.Interprocess Communication and Synchronization of Processes, Threads and Tasks: multiple processes in an application, multiple threads in an application, tasks, task status, task and data, clear – cut distention between functions, ISRS and tasks by their characteristics, concept of semaphores, shared data, interprocess communication, signal function, semaphore functions, message queue functions, mailbox functions, pipe functions, socket functions, RPC functions. | | | | | 10 | |
| 5 | | I-Time Operating Systems: nt functions, memory manage | | • | 0 | 10 | |

| interrupt routines in RTOS environment and handling of interrupt source calls, real – time operating systems, basic design using an RTOS, RTOS task scheduling models, interrupt latency and response of the task as performance metrics, OS security issues. | |
|---|-------------|
| Course outcomes: | |
| At the end of the course the student will be able to: | |
| 1. Understand the concept of embedded system. | |
| 2. Analyse the embedded system architecture and memory organization. | |
| 3. Analyse the real time system ARM processor. | |
| 4. Realise real time operating system. | |
| TEXT BOOKS/ REFERENCE BOOKS | · . |
| 1. Embedded Systems: Architecture, Programming and Design, Raj Kamal, McGraw Hill | $1, 2^{nd}$ |
| Edition,2014 | |
| Note: One question of 20 marks from each unit. Internal Choices must be provided in Uni | t 3 and |
| Unit 5. | |

| Sale Mannun | Subject title : ADVANCED CONTROL SYSTEMS | | | | | | |
|----------------|---|--|---|--|--|--------------------------|--|
| | Subject Code: 18EPE152 No. of Credits : 3:0:0:0 No. of lecture hours/week | | : 4 | | | | |
| | | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | s: 52 | |
| 1. Th 2. Th | ie non ie Opt ie Mou Digi Con Basi z – ' Plar | jective: In this course, studen linear systems and Digital Co imization of the control parar deling of Digital Control System figurations of the Basic Digit ic Discrete – Time Signals, Ti Fransform, Transfer Function and Jury Stability Criterion sing, Reconstruction of Analo | ntrol Systems neters using di ems. Syllabus co Terminology al Control Sch me Domain M Models, Freq , Sample and I | ifferent optim ntent 7, Need of Dig neme, Principl Models for Dis uency Respor Hold Systems | ital control, e of Signal Conversion, crete – Time Systems, The use, Stability on the z – , Sampled Spectra and | No. of hours 10 | |
| 2 | Sam Mo Des with | Aliasing, Reconstruction of Analog Signals, Practical Aspects of the choice of Sampling Rate, Principle of Discretization. Models of Digital Control Devices and Systems: Introduction, z – Domain Description of Sampled Continuous – time Plants, z – Domain Description of Samples with Dead – Time, Implementation of Digital Controllers, Tunable PID Controllers, Digital Temperature and Position Control Systems, Stepping Motors and their Control. | | | | | |
| 3 | of D Des Con Pole Stat Stat Sepa Feed | The Variable Analysis of Digit Digital Processors, State Description of Systems with Dead trollability and Observability, Placement Design and Stat e Feedback, Necessary and su e Regulator Design, Design o aration Principle, Servo Desig diforward Control, State Feedback a State Feedback, Deadbeat co | iption of Sam I Time, Soluti Multivariable e Observers: fficient Condi f State Observ n – Introducti pack with Inte | pled continuo on of State Di e Systems. Introduction, itions for Arbi yers, Compens ion of the refe gral Control, I | us – Time Plants, State ifference Equations, Stability Improvement by itrary Pole – Placement, ator Design by the rence Input by Digital Control Systems | 12 | |
| 4 | Quadratic Optimal Control: Introduction, The Concept of Lyapunov Stability, Lyapunov Functions for Linear Systems, Parameter Optimization and Optimal Control Problems, Quadratic Performance Index, Control Configurations, Optimal State Regulator, Optimal Digital Control Systems, Constrained State Feedback Control. | | | | | 10 | |
| 5 | Con Des | linear System Analysis: In nmon nonlinearities in Con cribing Function of Common ction Method, Concept of Ph | ntrol Systems n nonlinearitie | s, Describing es, Stability A | Function Fundamentals, Analysis by the Describing | 10 | |

System Analysis on the Phase Plane, Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems

Course outcomes:

At the end of the course the student will be able to:

- 1. Analyse the nonlinear systems and Digital Control Systems
- 2. Optimize the control parameters using different optimization techniques.
- 3. Model Digital Control Systems.

TEXT BOOKS

1. Digital Control and State Variable Methods (Conventional and Intelligent Control Systems) M Gopal, McGraw Hill, 3rdEdition,2008.

REFERENCE BOOKS

- 1. Discrete Time Control Systems, Katsuhiko Ogata.
- 2. Digital Control Systems, Benjamin C Kuo, Oxford University Press, 2nd Edition, 2007.

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 3 and Unit 5.

| AN INSTITUTE OF THE | | Subject title : POWER ELECTRONICS LABORATORY-I | | | | | | | |
|---------------------|---|--|-----------------|----------------|-------------------------------|----------|--|--|--|
| | | Subject Code: 18EPEL16 | No. of Cred | its : 2:0:0:0 | No. of lecture hours/week | : 3 | | | |
| Anded By Garry, of | Kantataka | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | : 39 | | | |
| Cours | Course objective: In this course, student learn | | | | | | | | |
| 1. | Th | e application of appropriate te | chniques to so | olve power ele | ectronics problem using mode | ern | | | |
| | too | •• •• • | 1 | 1 | | | | | |
| 2. | | e working collaboratively on | - | • | | | | | |
| 3. | Th | e computation of the perform | ance of vario | us converters. | | | | | |
| Unit No. | | | Syllabu | is content | | | | | |
| 1 | Ana | lysis of static and dynamic ch | aracteristic of | MOSFET and | d IGBT | | | | |
| 1 | | | | | | | | | |
| 2 | | formance of single phase ful inuous current mode. | ly controlled | and semi-con | ntrolled converter for RL lo | oad for | | | |
| 3 | | ormance of single phase ful ontinuous current mode. | ly controlled | and semi-con | ntrolled converter for RL lo | oad for | | | |
| 4 | | ly of effect of source indu- verter. | ctance on the | e performance | e of single phase fully cor | ıtrolled | | | |
| 5 | | ormance analysis of three ph continuous current mode. | ase fully cont | rolled and ser | ni-controlled converter for R | L load | | | |
| 6 | | ormance analysis of three ph liscontinuous current mode. | ase fully cont | rolled and ser | ni-controlled converter for R | L load | | | |
| 7 | | ormance analysis of single pl e width modulation. | hase bridge ir | verter for RL | load and voltage control by | ' single | | | |
| 8 | Perf | ormance analysis of two quac | lrant chopper. | | | | | | |
| 9 | Diode clamped multilevel inverter. | | | | | | | | |
| 10 | ZVS operation of a synchronous buck converter. | | | | | | | | |
| | Course outcomes: | | | | | | | | |
| | At the end of the course the student will be able to: | | | | | | | | |
| | | 1. Apply appropriate technic tools. | ques to solve j | power electror | nics problem using modern | | | | |
| | | Work collaboratively on multidisciplinary environment. | | | | | | | |

| CT STATUTE O | 10900 | Subject title | AC AND D | C DRIVES | | |
|---|---|--|---|---|---|--------------------|
| | | Subject Code: 18EPE21 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week | : 4 |
| | | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | : 52 |
| Course 1. 2. 3. Unit No. | Dif The | jective: In this course, student ferent Quadrant operation of Dri e concept of AC/DC variable fferent control methods of ele | ves speed drives. | | | No. of hours |
| 1 | Electric Drives : Introduction – block diagram-classification of electrical drives-choice of electrical drives-fundamental torque equation- components of load torque- steady state stability. | | | | | |
| 2 | quad Two | Drives : Single Quadrant Driver drants Drive: 1-phase and 3-pi o and Four Quadrant drive: 1- sing methods and closed loop | hase full conv -phase and thi | verter drive. ree- phase dua | | 12 |
| 3 | AC Drives: Voltage and current source inverter - inverter control-six step and PWM operation, Control of Induction motor drive -V/f and field oriented control – direct and indirect vector control, voltage and current source inverter fed induction motor drives, stator and rotor voltage control methods, slip energy recovery drives. | | | | | |
| 4 | Closed Loop Control of AC Drives : Basic principle of vector control, direct & indirect vector control of induction motor, stator voltage control, slip regulation, speed control of static Kramer's drive, closed loop control of synchronous motors. stepper motor. | | | | | |
| 5 | | Dications of Drives: Drive control hoist drives and centrifugal p | | or textile mills | s, steel rolling mills, cranes | 10 |
| | Course outcome: At the end of the course, students will be able to CO 1: Acquainted with the knowledge of various AC/DC drives. CO2: Demonstrate the knowledge of different quadrant operation of AC/DC drives. CO3: Develop the closed loop control of Electrical Drives. | | | | | |
| 1. Po Pro 2. Th | Mo Ele Ele REN wer entico yrist | OKS: odern Power Electronics & A ectric Motor Drives - R Krishi ectric Drives-Concepts and Ap NCE BOOKS: Electronics- Circuits, Dev e Hall 2010. tor Control of AC Motors- N Performance Control of AC 1 | nan, PHI, 2010 oplications- Vo vices and A Murphy JMD, | edam Subrahma pplications - Turnbull F.G | nyam, McGraw Hill, 2 nd edition Muhammad H. Rashid, I ., Pergamon Press Oxford. 19 | Pearson 998. |
| Note: | One | e question of 20 marks from | each unit. In Unit (| | es must be provided in Unit | 2 and |

| Sta sattur | O'HOMA | Subject title : SV | VITCHED MO | DE POWER CC | ONVERSION | |
|-------------------------|--|---|----------------------------------|---------------------|----------------------------|--------------------|
| Tra.s. | | Subject Code: 18EPE22 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week | : 4 |
| | | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | : 52 |
| Cours 1. 2. 3. | . Th . <mark>Th</mark> | ective: In this course, students e operating principles of diffe e Designing and controlling o e Simulation in computer for | rent power co f different pov | wer converters | | |
| Unit No. | | | Syllabus co | ontent | | No. of hours |
| 1 | DC – DC Converters (Basic Converters): Linear voltage regulators (LVRs), a basic switching converter(SMPC), comparison between LVR & SMPC, principle of operation and analysis of buck converter analysis, inductor current ripple and output voltage ripple, capacitor resistance effect, synchronous rectification, design considerations, buck converter for discontinuous current operation, principle of operation and analysis of boost converter, inductor current ripple and output voltage ripple, inductor resistance effect, design considerations, boost converter for discontinuous current operation, principle of operation and analysis of buck boost converter analysis, inductors current ripple and output voltage row converter analysis, inductors current ripple and output voltage ripple, design considerations for continuous current mode operation. | | | | | |
| 2 | Buck-boost converter for discontinuous current operation, principle of operation and analysis of CUK converter, inductor current ripple and output voltage ripple, capacitor resistance effect, design considerations, single ended primary inductance converter(SEPIC). Derived Converters : Introduction, transformer models, principle of operation and analysis of fly back converter-continuous and discontinuous current mode of operation, design considerations, principle of operation and analysis of forward converter, design considerations. | | | | | |
| 3 | Double ended (Two switch) forward converter, principle of operation and analysis of push-pull converter, design considerations, principle of operation and analysis of full bridge and half-bridge DC-DC converters, design considerations, current fed | | | | | |
| 4 | converters, multiple outputs. Control of DC-DC Converter: Modeling of DC-DC converters, power supply control, control loop stability, small signal analysis, switch transfer function, filter transfer function, PWM transfer function, Type-2 error amplifier with compensation, design, PSpice simulation of feedback control, Type-3 error amplifier with compensation, design. | | | | | |
| 5 | Resonant Converters : Introduction, resonant switch ZCS converter, principle of operation and analysis, resonant switch ZVS converter, principle of operation and analysis, series resonant inverter, series resonant DC-DC converter, parallel resonant DC-DC converter, resonant converters comparison, resonant DC link converter. Design of inductor and transformers for SMPC. | | | | | 10 |
| | CO CO | Trse outcome: At the end of the 1: Analyze and distinguish the 2: Design and control the different 3: Simulate in computer for R | e power conv ferent power c | erters onverters | | |

TEXT BOOKS:

- 1. **Power Electronics-** Daniel W Hart Tata McGraw Hil 1, 2011.
- 2. Power Electronics Circuits Devices and Applications -Rashid M.H., 3rd Edition, Pearson, 2011.

REFERENCE BOOKS:

- 1. DC-DC Switching Regulator Analysis D M Mitchel M cGraw-Hill Ltd, 1988.
- 2. Design of Magnetic Compon ents for Switched Mode Power Converters- Umanand L and Bhatt S R New Age International, New Delhi, 2001
- **3.** Power Electronics Converters, Applications, and Design-Ned Mohan, Tore M. Undeland, William P. Robbins 3rd Edition, Wiley India Pvt Ltd, 2010.

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 1 and Unit 2.

| Augest PERiod Reliting and |
|----------------------------|

| Subject t | itle : POWE | R ELECTRO | NICS SYSTEM DESIGN |
|-------------------------|-------------|---------------|--------------------------------|
| | USING LI | NEAR ICs | |
| Subject Code: 18EPE23 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week : 4 |
| Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours: 52 |

Course objective: To enable students learn

1. To explain basic and necessary requirements for designing a regulator circuit.

- 2. To discuss various types of PWM ICs used for designing regulator circuits.
- 3. To introduce and explain basics of PLC and programming of PLC.

| Unit No. | Svilabus content | | | | |
|---------------|---|-----------|--|--|--|
| 1 | Introduction : Measurement techniques for voltages, current, power, power factor in power electronic circuits, other recording and analysis of waveforms, sensing of speed | | | | |
| 2 | Switching Regulator Control Circuits: Introduction, isolation techniques of switching regulator systems, PWM systems. | 10 | | | |
| 3 | Commercial PWM Control ICs and their Applications: TL 494 PWM control IC, UC 1840 programmable off line PWM controller, UC 1524 PWM control IC, UC 1846 current mode control IC, UC 1860 resonant mode power supply controller. Switching power supply ancillary, supervisory & peripheral circuits and components: introduction, optocouplers, self-biased techniques used in primary side of reference power supplies, soft/start in switching power supplies. | | | | |
| 4 | Protection of Switching power supply systems: current limit circuits, over voltage protection, AC line loss detection. Phase – Locked Loops (PLL) & Applications: PLL Design using ICs, 555 timer & its applications, analog to digital converter using IC's, digital to analog converters using ICs, implementation of different gating circuits. Various ADC and DAC circuits. | 10 | | | |
| 5 | Programmable Logic Controllers (PLC): Basic configuration of a PLC, programming and PLC, program modification, power converter control using PLCs. ICs for Switch-Mode Power Supplies: Control ICs for Switch mode power supplies, IC timers as controllers for switch-mode power supplies. | 10 | | | |
| | Course outcome: At the end of the course, students will be able to CO 1: identify Types of measuring instruments required in PE circuits. CO 2: Detailed methods of protection & isolation requirements CO 3: Different ICs available for various purposes (PWM generation, protection etc). CO 4: Basics of PLC and basic programming methods of PLC | | | | |
| TEX 1. | F BOOKS: "Thyristorised Power Controllers", G. K. Dubey, S. R. Doradla, A. Johsi, and R. M. K | Sinha | | | |
| 1. | 2ndEdition, New Age International, 2010. | . Sillid, | | | |
| 2. | | | | | |
| 3. | Unitrode application notes: http://www.smps.us/Unitrode.html | | | | |

REFERENCE BOOKS:

1. "Switch- Mode Power Supply Design", P.R.K. Chetty, BPB Publications.

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 3 and Unit 4.

| STANTIUTE O | 110mo | Subject title : El | LECTRIC V | EHICLE TE | CHNOLOGY | |
|----------------------------|---|--|-------------------------|-----------------|-----------------------------|--------------------|
| | | Subject Code: 18EPE253 | No. of Cred | its : 3:0:0:0 | No. of lecture hours/week | : 4 |
| Added By Govet of Ramataka | | Exam Duration : 3 hours | CIE : 50 | SEE : 50 | Total No. of lecture hours | : 52 |
| 1. A 2. V 3. C | dvar ariou hara | e objective: : In this course, st ntages of EVs. as drive trains cteristics of various types of b pt of hybrid electric vehicles | | | | |
| Unit No. | | | Syllabus co | ontent | | No. of hours |
| 1 | impa stan | oduction to electric vehicle acts. EV market and promo dardization. | tion: infrastr | ucture needs | legislation and regulation, | 10 |
| 1 | sing perf | etric vehicle (EV) design op le- vs. multiple-motor drive, ormance specifications. Cho ection. | in-wheel driv | es. EV parai | meters, driving cycles and | 10 |
| 2 | Vehicle dynamics and motor drives: Road load: vehicle kinetics; effect of velocity, acceleration and grade. EV drive train and components. EV motor drive systems: DC drives, induction motor drives, permanent-magnet synchronous motor drives, switched reluctance motor drives. Control strategies. | | | | | 10 |
| 3 | Batteries: Battery parameters. Types and characteristics of EV batteries. Battery testing and maintenance; charging schemes. Battery monitoring techniques. Open- circuit voltage and ampere- hour estimation. Battery load levelling | | | | | 10 |
| 4 | Emerging EV technologies: Hybrid electric vehicles (HEVs): types, operating modes, torque coordination and control, generator/motor requirements. | | | | | 10 |
| 5 | refo | l cell electric vehicles (FEVs rmers. Alternative sources of | power: super- | - and ultra- ca | pacitors, flywheels. | 10 |
| | | Irse outcome: At the end of the local section | | | able to | |
| | | 1: Describe the configuration 2: Differentiate among differe | • • | | | |
| | | 3: Understand the limitations | | | pattery chemistries. | |
| | | 4: Develop strategies for char | | | | |
| ГЕХТ | | 5: Describe the various drive | trains of hybri | d electric vehi | icles. | |
| 1. 1. | Mo boi | odern Electric Vehicle Tech ndon ectric and Hybrid Vehicles: 1 | | | • | Press, |
| REFE 1. | Mo | ICE BOOKS: odern Electric, Hybrid Ele | | | | ry and |
| 2. | | sign- M. Ehsani, Y. Gao, S .E e b address- Batteryuniversity | - | Emadi, - New | York: CRC Press | |
| Note: | One | question of 20 marks from | each unit. In Unit (| | es must be provided in Unit | 1 and |



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

| SI | Subject Code | Subject title | Mannadta |
|-----|--------------|---|---|
| No | | | Mapped to Employability/Entrepreneur/Skill |
| 1. | EPE12 | Power Semiconductor Devices and Components | Employability |
| 2. | EPE13 | Solid State Power Controllers | Employability |
| 3. | EPE14 | Modelling and Simulation of Power Electronics. | Entrepreneur |
| 4. | EPE151 | Embedded Systems | Skill |
| 5. | EPE153 | Advanced Control Systems | Skill |
| 6. | EPEL16 | Power Electronics Laboratory-1 | Skill |
| 7. | EPE21 | AC and DC Drives | Skill |
| 8. | EPE22 | Switched Mode Power Conversion | Employability |
| 9. | EPE23 | Modelling and Analysis of Electrical Machines | Employability |
| 10. | EPE253 | Electric Vehicle Technology | Entrepreneur |
| 11. | EPE41 | HVDC power Transmission | Employability |
| 12. | EPE421 | MPPT in solar systems | Employability |
| 13. | EPE422 | PWM converters and applications | Employability |
| 14. | EPE423 | DSP applications to drives | Skill |

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BOS Chairman

Principal



Subject title : POWER SEMICONDUCTOR DEVICES AND COMPONENTS

| Circl. of Kanada | Subject Code: EPE12 | No. of Credits : 4:0:0:0 | | No. of lecture hours/week : 4 | |
|------------------|----------------------------|-----------------------------|----------|--------------------------------|--|
| | Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hours: 52 | |

Course objective: In this course, student learn

- 1. Working of various power semiconductor devices.
- 2. Analyzing the switching parameters to decide the suitability of application.
- 3. Modeling and simulation of devices along with protection system.

| Unit No. | Syllabus content | No. of hours |
|-------------|--|--------------------|
| 1 | Basic Semiconductor Physics: Introduction, Conduction Processes in Semiconductors pn Junctions, Charge Control Description of pn-Junction Operation, Avalanche Breakdown. Power Diodes: Introduction, Basic Structure and I – V characteristics, Breakdown Voltage Considerations, On –State Losses, Switching Characteristics, Schottky Diodes. | 10 |
| 2 | Bipolar Junction Transistors: Introduction, Vertical Power Transistor Structures, I-V Characteristics, Physics of BJT Operation, Switching Characteristics, Breakdown Voltages, Second Breakdown, On-State Losses, Safe Operating areas. Power MOSFETs :Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Switching Characteristics, Operating Limitations and Safe Operating Areas. | 12 |
| 3 | Thyristors: Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Switching Characteristics, Methods of Improving di/dt and dv/dt Ratings. Gate Turn-Off Thyristors: Introduction, Basic Structure and I-V Characteristics, Physics of Turn-Off Operation, GTO Switching Characteristics, Overcurrent Protection of GTOs. Insulated Gate Bipolar Transistors: Introduction, Basic Structure, I-V Characteristics, Physics of Device Operation, Latchup in IGBTs, Switching Characteristics, Device Limits and SOAs. | 10 |
| 4 | Emerging Devices and Circuits: Introduction, Power Junction Field Effect Transistors, Field-Controlled Thyristor, JFET-Based Devices versus Other Power Devices, MOS-Controlled Thyristors, Power Integrated Circuits, New Semiconductor Materials for Power Devices. Snubber Circuits: Function and Types of Snubber Circuits, Diode Snubbers, | 10 |

| | Snubber Circuits for Thyristors, Need for Snubbers with Transistors, Turn-Off | | | |
|------------------|--|-----|--|--|
| | Snubber, Overvoltage Snubber, Turn-On Snubber, Snubbers for Bridge Circuit | | | |
| | | | | |
| | Configurations, GTO Snubber Considerations. | | | |
| | Component Temperature Control and Heat Sinks: Control of Semiconductor | | | |
| | Device Temperatures, Heat Transfer by Conduction, Heat sinks, Heat Transfer by | | | |
| | Radiation and Convection. | | | |
| | | | | |
| 5 | Design of Magnetic Components: Magnetic Materials and Cores, Copper Windings, Thermal Considerations, Analysis of a Specific Inductor Design, Inductor Design Procedures, Analysis of a Specific Transformer Design, Eddy Currents, Transformer Leakage Inductance, Transformer Design Procedure, Comparison of Transformer and Inductor Sizes. | 10 | | |
| | Course outcome: At the end of the course, students will be able to | | | |
| | CO 1 : Understand the working of various power semiconductor devices CO2 : Analyze the switching parameters to decide the suitability of application. CO3 : Modeling and simulation of devices along with protection system | | | |
| TEXT | Г BOOKS: | | | |
| 1. | Power Electronics Converters, Applications, and Design- Ned Mohan et al, Wild 3 rd Edition,2014 | ey, | | |
| REFERENCE BOOKS: | | | | |
| | | | | |
| | Power Electronics - Daniel W Hart, McGraw Hill | | | |
| 2. | Power Semiconductor Devices - B. Jayant Baliga, Springer, 2008 | | | |
| | | | | |

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 2 and Unit 3.

| is sometime | Subject title : | Solid Stat | e Power Con | trollers | | | |
|------------------|---|--|-----------------|-----------------------------|--------------------|--|--|
| C | Subject Code: RPR13 | o. of Cred :0:0:0 | lits : | No. of lecture hours/weel | k: 4 | | |
| Anted By Gave of | Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hours: | | | |
| Cours | se objective: In this course, student l | earn | | | | | |
| 1. | Analyzing various operating modes | of differe | nt power con | verters. | | | |
| 2. | Designing various AC/ DC power c | onverters. | | | | | |
| 3. | Designing of control circuits for po | wer conve | rters using di | fferent methods. | | | |
| Unit No. | S | yllabus co | ontent | | No. of hours | | |
| | Line Commutated Converters: Pl | nase contro | ol, single phas | se semi-converter & fully | | | |
| | controlled converter, three phase se | | - | | 14 | | |
| 1 | | er factor improvement methods, effect of source inductance, single | | | | | |
| | phase series converters, twelve pulse converter and design of converter circuits | | | | | | |
| | Inverters: Principle of operation, performance parameters, single phase bridge | | | | | | |
| 2 | inverters and three phase inverters. | | | | | | |
| | Voltage Control of Single Phase I | nverters: | Single/multip | ble, pulse/SPWM/ modified | | | |
| 2 | SPWM methods, voltage control | | | | 10 | | |
| 3 | PWM/Space vector modulation, comparison between VSI & CSI. | harmonic | e reduction, | current source inverter, | 10 | | |
| | comparison between visite esi. | | | | | | |
| | Multilevel Inverters: Introduction | , types, dio | ode clamped r | nulti-level inverters, | 0.0 | | |
| 4 | features & applications. | | | | 08 | | |
| | DC-DC Converters: Principle of | | | | | | |
| 5 | converters, , Push – Pull (Symmet | | | | 10 | | |
| 3 | Continuous Mode, Output Characte Hamilton Circuit, Ćuk Converters. | eristics, Ha | alf-Bridge Co | onverter, Bridge Converter, | 10 | | |
| | Hammon Cheun, Cuk Converters. | | | | | | |
| | Course outcome: At the end of the | course, st | udents will be | e able to | | | |
| | CO 1 : Analyze various operating m | odes of di | fferent power | converters. | | | |
| | CO2: Design various power conver | rters. | - | | | | |
| | CO3: Design control circuits for po | ower conve | erters using di | fferent methods. | | | |
| | | | | | | | |
| | 「BOOKS/ REFERENCE BOOKS ower Electronics Converters, App | | and Design | -Ned Mohan, Tore M Un | deland | | |

- Power Electronics Converters, Applications, and Design -Ned Mohan, Tore M. Undeland, William P. Robbins, 3rdEdition, Wiley India Pvt Ltd, 2011
 Power Electronics: Circuits Devices and Applications-Rashid M.H 3rd Edition, Pearson, 2011.
 Modern Power Electronics & AC Drives- B. K. Bose PHI, 2012.

| and an and a second | 100 | Subject title : MODELI ELECTRON | | MULATION | N FOR POWER | |
|---------------------|--|---|--|---|---|--------------------|
| | | Subject Code: EPE14 | No. of Cree 4:0:0:0 | dits : | No. of lecture hours/weel | k: 4 |
| Auded By Garris of | Renatika | Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hour | rs: 52 |
| Cours | se ob | jective: In this course, stude | nt learn | | | |
| 1. 2. | • • | es of modeling applicable o p es and need for control syster | | nics | | |
| 3. | | trol system design for conver | | | | |
| 4. | <mark>to a</mark> | inalyze a system and to make | e use of the ii | nformation to | improve the performance. | NT |
| Unit No. | | | Syllabus co | | | No. of hours |
| 1 | Computer Simulation of Power Electronic Converters and Systems: Introduction, Challenges in Computer Simulation, Simulation Process, Mechanics of Simulation, Solution Techniques for Time-Domain Analysis, Widely Used, Circuit-Oriented Simulators, Equation Solvers. Modeling of Systems: Input-Output relations, Differential Equations and Linearization, State Space Representation, Transfer Function Representation, Block Diagrams, Lagrange method, Circuit Averaging, Bond Graphs, Space Vector Modeling | | | | | 12 |
| 2 | Control System Essentials: Control System Basics, Control Principles, State - Space Method, Bode Diagram Method, Root Locus Method, State Space Method | | | | 10 | |
| 3 | Digital Controller Design: Controller Design Techniques, , PID Controller, , Full State Feedback, Regulator Design by Pole Placement, Estimation Design, Tracker : Controller Design | | | | 10 | |
| 4 | Cor Fee Opt Mir Rec | ital Controller Design (con ntrol of Induction motor, Out dback. timal and Robust Controlle nimum Energy Principle, I cursive Least Squares, Opt mple, Robust Controller Desi | tput Feedbac e r Design: Le Least Squard imal Contro | k, Induction 1 east Squares F e Solution, | motor Control with Output Principle, Quadratic Forms, Weighted Least Squares, | 12 |
| 5 | | crete Computation Essentia ed Point System, Normalizati | | | e | 08 |

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

- **CO 1**: understand the system concept and apply functional modeling method to model the activities of a static system
- **CO2:** understand the behavior of a dynamic system and create an analogous model for a dynamic system
- **CO3:** simulate the operation of a dynamic system and make improvement according to the simulation results

TEXT BOOKS/ REFERENCE BOOKS:

- 1. **Power Electronics Converters, Applications, and Design** Ned Mohan, Wiley, 3rdEdition,2014
- 2. **Power Electronics Essentials and Applications** L.Umanand, Wiley, 1st Edition, 2014

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 1 and Unit 4.

| a statitute or ju | Subject title : EMBEDDED SYSTEMS | | | | |
|----------------------------|----------------------------------|-----------------------------|----------|--------------------------------|--|
| | Subject Code: EPE151 | No. of Credits : 4:0:0:0 | | No. of lecture hours/week : 4 | |
| Added By Govt: of Kamataka | Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hours: 52 | |

Course objective: In this course, student learn

- 1. the concepts of embedded system.
- 2. embedded system architecture and memory organization.
- 3. (the interprocess communication, modeling, devices and communication buses).
- 4. realisation of real time operating system.

| Unit No. | Syllabus content | No. of hours |
|-------------|--|--------------------|
| 1 | Introduction to Embedded Systems: Embedded Systems, Processor Embedded into a System, Embedded Hardware Units and Devices in a System, Embedded Software in a System, Examples of Embedded Systems, Embedded Systems – on –chip (Soc) and Use of VLSI Circuit Design Technology, Complex Systems Design and Processors, Design of Process in Embedded System, Formulation of System Design, Design Process and Design Examples, Classification of Embedded Systems, Skill required for an Embedded System Designer. | 10 |
| 2 | Processor Architecture and Memory Organisation: 8051 Architecture, Real world Interfacing, Introduction to Advanced Architecture, Processor and Memory Organization, Instruction Level Parallelism, Performance Metrics, Memory – Types, Memory – Maps and Addresses, Processor Selection, Memory Selection. | 12 |
| 3 | Devices and Communication Buses, Interrupt Services: IO Types and Examples, Serial Communication Devices, Parallel Device Ports, Sophisticated Interfacing Features in Device Ports, Wireless Devices, Timer and Counting Devices, Watchdog Timer, Real Time Clock, Networked Embedded Systems, Serial Bus Device Protocols – Parallel Communication Network Using ISA,PCI, PCI –X and Advanced Protocols. | 10 |

| | Device Drivers and Interrupts Service Mechanisms: Programmed – I/O Busy – | | | |
|-----|--|------------|--|--|
| | wait Approach without Interrupt Service Mechanism, ISR Concept, Interrupt | | | |
| | Sources, Interrupt Servicing Mechanism, Direct Memory Access | | | |
| | Program Modelling concepts: Program Models, DFG Models, State Machine | | | |
| | Programming Models for Event – controlled Program Flow. | | | |
| | Interprocess Communication and Synchronization of Processes, Threads and | | | |
| | Tasks: Multiple Processes in an Application, Multiple Threads in an Application, | | | |
| 4 | Tasks, Task Status, Task and Data, Clear – cut Distention Between Functions, ISRS | 10 | | |
| | and Tasks by their Characteristics, Concept of Semaphores, Shared Data, | | | |
| | Interprocess Communication, Signal Function, Semaphore Functions, Message | | | |
| | Queue Functions, Mailbox Functions, Pipe Functions, Socket Functions, RPC | | | |
| | Functions. | | | |
| 5 | Real - Time Operating Systems: OS Services, Process Management, Timer Functions, Event Functions, Memory management, Device, File and IO Subsystems Management, Interrupt Routines in RTOS Environment and Handling of Interrupt Source Calls, Real – time Operating Systems, Basic Design Using an RTOS, RTOS Task Scheduling Models, Interrupt Latency and Response of the task as performance Metrics, OS Security Issues. | 10 | | |
| | Course outcomes: | | | |
| | At the end of the course the student will be able to: | | | |
| | 1. Understand the concept of embedded system. | | | |
| | 2. Analyse the embedded system architecture and memory organization. | | | |
| | 3. Analyse the real time system ARM processor. | | | |
| | 4. Realise real time operating system. | | | |
| | F BOOKS/ REFERENCE BOOKS . Embedded Systems : Architecture, Programming and Design, Raj Kamal, McGraw H | 311 2nd | | |
| | Edition,2014 | , <i>∠</i> | | |
| | | | | |
| Not | e: One question of 20 marks from each unit. Internal Choices must be provided in U | Unit 3 | | |
| | and Unit 5. | | | |

2. Harmonics and Power Systems-Francisco C. DE LA Rosa, CRC Press, 1st Edition, 2006

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 3 and Unit 4.

| | Subject title : ADVANCED CONTROL SYSTEMS | | | | | |
|-----------|---|-----------------------------|----------|--------------------------------|--|--|
| | Subject Code: EPE153 | No. of Credits : 4:0:0:0 | | No. of lecture hours/week : 4 | | |
| | Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hours: 52 | | |
| Course ob | Course objective: In this course, student learn | | | | | |

Course objective: In this course, student learn

1. The nonlinear systems and Digital Control Systems

The Optimization of the control parameters using different optimization techniques.
 The Modeling of Digital Control Systems.

| Unit No. | Syllabus content | No. of hours |
|-------------|--|--------------------|
| 1 | Digital Control: Control System Terminology, Need of Digital control, Configurations of the Basic Digital Control Scheme, Principle of Signal Conversion, Basic Discrete – Time Signals, Time Domain Models for Discrete – Time Systems, The z – Transform, Transfer Function Models, Frequency Response, Stability on the z – Plane and Jury Stability Criterion, Sample and Hold Systems, Sampled Spectra | 10 |

| | and Aliasing, Reconstruction of Analog Signals, Practical Aspects of the choice of | |
|-------|---|-----|
| | Sampling Rate, Principle of Discretization. | |
| | | |
| 2 | Models of Digital Control Devices and Systems: Introduction, z – Domain Description of Sampled Continuous – time Plants, z – Domain Description of Samples with Dead – Time, Implementation of Digital Controllers, Tunable PID Controllers, Digital Temperature and Position Control Systems, Stepping Motors and their Control. | 10 |
| 3 | State Variable Analysis of Digital Control Systems: Introduction, State Description of Digital Processors, State Description of Sampled continuous – Time Plants, State Description of Systems with Dead Time, Solution of State Difference Equations, Controllability and Observability, Multivariable Systems. Pole Placement Design and State Observers: Introduction, Stability Improvement by State Feedback, Necessary and sufficient Conditions for Arbitrary Pole – Placement, State Regulator Design, Design of State Observers, Compensator Design by the Separation Principle, Servo Design – Introduction of the reference Input by Feedforward Control, State Feedback with Integral Control, Digital Control Systems with State Feedback, Deadbeat control by State Feedback and Deadbeat Observers. | 12 |
| 4 | Quadratic Optimal Control: Introduction, The Concept of Lyapunov Stability, Lyapunov Functions for Linear Systems, Parameter Optimization and Optimal Control Problems, Quadratic Performance Index, Control Configurations, Optimal State Regulator, Optimal Digital Control Systems, Constrained State Feedback Control. | 10 |
| 5 | Nonlinear System Analysis: Introduction, Common nonlinear System Behaviours, Common nonlinearities in Control Systems, Describing Function Fundamentals, Describing Function of Common nonlinearities, Stability Analysis by the Describing Function Method, Concept of Phase Plane Analysis, Construction of Phase Portraits, System Analysis on the Phase Plane, Simple Variable Structure Systems, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems | 10 |
| | Course outcomes: | |
| | At the end of the course the student will be able to: | |
| | Analyse the nonlinear systems and Digital Control Systems Optimize the control parameters using different optimization techniques. Model Digital Control Systems. | |
| 1. Di | T BOOKS gital Control and State Variable Methods (Conventional and Intelligent Control Systems) opal, McGraw Hill, 3 rd Edition,2008. |) M |

REFERENCE BOOKS

- Discrete Time Control Systems, Katsuhiko Ogata.
 Digital Control Systems, Benjamin C Kuo, Oxford University Press, 2nd Edition,2007.



| Subject title | : POWER I | ELECTRON | ICS LABORATORY-I |
|----------------------------|------------------------|----------|--------------------------------|
| Subject Code: EPEL16 | No. of Cred 2:0:0:0 | lits : | No. of lecture hours/week : 3 |
| Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hours: 39 |

Course objective: In this course, student learn

- 1. The application of appropriate techniques to solve power electronics problem using modern tools.
- 2. The working collaboratively on multidisciplinary environment.
- 3. The computation of the performance of various converters

| Unit No. | Syllabus content |
|-------------|--|
| 1 | Analysis of static and dynamic characteristic of MOSFET and IGBT |

| 2 | Performance of single phase fully controlled and semi-controlled converter for RL load for continuous current mode. | | | | | |
|----|--|--|--|--|--|--|
| 3 | Performance of single phase fully controlled and semi-controlled converter for RL load for discontinuous current mode. | | | | | |
| 4 | Study of effect of source inductance on the performance of single phase fully controlled converter. | | | | | |
| 5 | Performance analysis of three phase fully controlled and semi-controlled converter for RL load for continuous current mode. | | | | | |
| 6 | Performance analysis of three phase fully controlled and semi-controlled converter for RL load for discontinuous current mode. | | | | | |
| 7 | Performance analysis of single phase bridge inverter for RL load and voltage control by single ulse width modulation. | | | | | |
| 8 | Performance analysis of two quadrant chopper. | | | | | |
| 9 | Diode clamped multilevel inverter. | | | | | |
| 10 | ZVS operation of a Synchronous buck converter. | | | | | |
| | Course outcomes: | | | | | |
| | At the end of the course the student will be able to: | | | | | |
| | 1. Apply appropriate techniques to solve power electronics problem usage of modern tools. | | | | | |
| | 2. Work collaboratively on multidisciplinary environment. | | | | | |

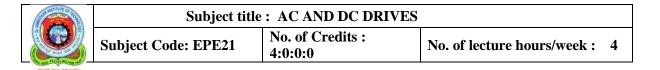
| A SUBTRUE OF TO | Subject | title : SEM | INAR | |
|-------------------------|---------------------|-------------|----------------|-----------------------------|
| | Subject Code: EPE17 | No. of Cred | lits : 2:0:0:0 | No. of lecture hours/week : |
| And By Gort, of Ramabia | Exam Duration : | CIE : 30 | SEE : 70 | Total No. of lecture hours: |
| | | | | |

The objective of the Mini Project / Industrial Visit /Field Work is to inculcate self-learning, to carryout mini Innovative projects/to enhance industrial /practical knowledge/ to carryout field work.

Each student, under the guidance of a Faculty, is required to

- i) Choose a topic of his/her interest relevant to the Course of Specialization
- ii) Carryout literature survey, organize the subject topics in a systematic order
- iii) Prepare the report with own sentences
- iv) Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities
- v) Present the seminar topic at least for 20 minutes orally and/or through power point slides
- vi) Answer the queries and involve in debate/discussion lasting for about 10 minutes
- vii) Submit two copies of the typed report with a list of references

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.



| | Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hour | rs: 52 | | |
|-------------------------|---|--|---------------------------------|--|--------------------|--|--|
| Cours 1. 2. 3. | The concept of AC/DC variable | rives e speed drives | | | | | |
| Unit No. | | Syllabus co | | | No. of hours | | |
| 1 | | Electric Drives : Introduction – block diagram-classification of electrical drives- choice of electrical drives-fundamental torque equation- components of load torque- steady state stability. | | | | | |
| 2 | DC Drives : Single Quadrant Dri quadrants Drive: 1-phase and 3- Two and Four Quadrant drive: 1- braking methods and closed loop | phase full con phase and the | verter drive. ree- phase dua | | 12 | | |
| 3 | AC Drives: Voltage and current operation, Control drive -V/f and field oriented con current source inverter fed indu methods, slip energy recovery dr | of ntrol – direct action motor | In and indirect | nduction motor vector control, voltage and | 12 | | |
| 4 | Closed Loop Control of AC Drives : Basic Principle of Vector Control, Direct & Indirect Vector control of Induction Motor, Stator voltage control, Slip regulation, Speed control of static Kramer's drive, Closed loop control of Synchronous Motors. Stepper Motor | | | | | | |
| 5 | | Applications of Drives: Drive Consideration for Textile Mills, Steel Rolling Mills, Cranes and Hoist Drives and Centrifugal Pumps. | | | | | |
| | Course outcome: At the end of CO 1: Acquainted with the know CO2: Demonstrate the knowled CO3: Develop the closed loop of | vledge of vari ge of differer | ious AC/DC d nt quadrant op | lrives. peration of AC/DC drives. | | | |
| 1. 2. 3. | Electric Motor Drives - R Krist | nnan, PHI, 201 | 0 | | tion, | | |

- 1. Power Electronics- Circuits, Devices and Applications Muhammad H. Rashid, Pearson Prentice Hall 2010.
- 2. Thyristor Control of AC Motors- Murphy JMD, Turnbull F.G., Pergamon Press Oxford. 1998.
 3. High Performance Control of AC Drives- MehrdadEhsani, YiminGaoAlinEmadi, Wiley, 2012.

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 2 and Unit 3.



Subject title : SWITCHED MODE POWER CONVERSION

| | Subject Code: EPE22 | No. of Cre 4:0:0:0 | dits : | No. of lecture hours/wee | k: 4 | |
|-------------|--|---|--|--|--------------------|--|
| | Exam Duration : 3 hoursCIE : 30SEE : 70Total No. of lecture hours | | | | | |
| | the operating principles of diff (the Designing and controlling) | erent power c of different p | ower converte | | | |
| Unit No. | | Syllabus c | | | No. of hours | |
| 1 | DC – DC Converters (Basic C switching converter(SMPC), o operation and analysis of buck voltage ripple, capacitor res considerations, buck converter operation and analysis of boost ripple, inductor resistance ef discontinuous current operation converter analysis, inductors considerations for continuous cu | comparison converter and sistance effer for discom converter, in fect, desig n, principle c current ripp | between LVR alysis, inducto ect, synchron tinuous curren aductor curren n considerati of operation a ole and output | & & SMPC, principle of r current ripple and output ous rectification, design nt operation, principle of t ripple and output voltage ons, boost converter for nd analysis of buck boost | 12 | |
| 2 | Buck-boost converter for disco analysis of CUK converter, indu | ntinuous curr actor current onsiderations tion, transfor er-continuous ns, principle | ent operation, ripple and outp , single end mer models, s and discon | but voltage ripple, capacitor ded primary inductance principle of operation and tinuous current mode of | 10 | |
| 3 | Double ended (Two switch) for push-pull converter, design con bridge and half-bridge DC-L converters, multiple outputs. | siderations, p | principle of op | eration and analysis of full | 10 | |
| 4 | Control of DC-DC Converte control, control loop stability, transfer function, PWM transfe design, PSpice simulation of compensation, design. | small signal r function, T | analysis, swit | ch transfer function, filter plifier with compensation, | 10 | |
| 5 | Resonant Converters : Introduce operation and analysis, resonant analysis, resonant inverted DC-DC converter, series- para comparison, resonant DC link comparison of inductor and transference of the series of th | nt switch ZV er, series reso illel resonant onverter. | S converter, nant DC-DC o DC-DC conv | principle of operation and converter, parallel resonant | 10 | |
| | Course outcome: At the end of CO 1: Analyze and distinguish to CO 2: Design and control the di CO 3: Simulate in computer for | the power con fferent powe | nverters r converters | | | |

TEXT BOOKS:

- 1. **Power Electronics-** Daniel W Hart Tata McGraw Hil 1, 2011.
- 2. Power Electronics Circuits Devices and Applications -Rashid M.H., 3 rd Edition, Pearson, 2011.

REFERENCE BOOKS:

- 1. DC-DC Switching Regulator Analysis D M Mitchel M cGraw-Hill Ltd, 1988.
- 2. Design of Magnetic Compon ents for Switched Mode Power Converters- Umanand L and Bhatt S R New Age International, New Delhi, 2001
- **3.** Power Electronics Converters, Applications, and Design-Ned Mohan, Tore M. Undeland, William P. Robbins 3 rd Edition, Wiley India Pvt Ltd, 2010.

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 1 and Unit 2.

| Exam Duration : 3 CIE : 30 SEE : 70 Total No. of lecture hours: 52 | Santure of Top | Subject title: MODELING AND ANALYSIS OF ELECTRICAL MACHINES | | | | | |
|--|----------------------------|---|----------|----------|--------------------------------|--|--|
| CIE: 30 SEE: 70 Total No. of lecture hours: 52 | | Subject Code: EPE23 | | lits : | No. of lecture hours/week : 4 | | |
| nouis | Autod By Gave. of Ramataka | Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hours: 52 | | |

Course objective: In this course, student

1. understand the concept of 2-axis representation of an Electrical machine.

- 2. will know the concepts of representing transfer function model of a DC machine
- 3. understand the importance of 3-phase to 2-phase conversion
- 4. will know the representation of 3-phase induction motor in various reference frames

| Unit No. | Syllabus content | No. of hours |
|-------------|--|--------------------|
| 1 | Basic Concepts of Modeling : Basic two pole machine representation of commutator machines, 3-phase synchronous machine with and without damper bar and 3-phase induction machine, Kron's primitive machine-voltage, current and torque equations. DC Machine Modeling : Mathematical model of separately excited DC motor-steady state and transient state analysis, sudden application of inertia load, transfer function of separately excited DC motor, mathematical model of dc series motor, shunt motor, linearization techniques for small perturbations. | 10 |
| 2 | Reference Frame Theory: Real time model of a two phase induction machine, transformation to obtain constant matrices, three phase to two phase transformation, power equivalence. Dynamic Modelling of Three Phase Induction Machine: Generalized model in arbitrary frame, electromagnetic torque, deviation of commonly used induction motor models-stator reference frames model, rotor reference frames model, synchronously rotating reference frames model, equations in flux linkages, per unit model, dynamic simulation. Small Signal Equations of the Induction Machine: Derivation of small signal equations of induction machine, space phasor model, DQ flux linkages model derivation, control principle of the induction motor. | 12 |
| 3 | Transformer Modelling : Introduction, single phase transformer model, three phase transformer connections, per phase analysis, normal systems, per unit normalization, per unit three phase quantities, change of base, per unit analysis of normal system, regulating transformers for voltage and phase angle control, auto transformers, transmission line and transformers | 10 |
| 4 | Modelling of Synchronous Machines : Introduction, voltage equations and torque equation in machine variables, stator voltage equations in arbitrary and rotor reference frame variables, Park's equations, torque equations in substitute variables, rotor angle and angle between rotors, per unit system, analysis of steady state operation. | 10 |
| 5 | Dynamic Analysis of Synchronous Machines: Dynamic performance during sudden change in input torque and during a 3-phase fault at the machine terminals, approximate transient torque versus rotor angle characteristics, comparison of actual and approximate transient torque-angle characteristics during a sudden change in input torque; first swing transient stability limit, comparison of actual and approximate transient torque-angle characteristics during a 3-phase fault at the machine terminals, critical clearing time, equal area criterion, computer simulation. | 10 |

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

- CO 1: Develop models for linear and nonlinear magnetic circuits
- CO 2: Determine the developed torque in an electrical machines using the concepts of filed energy and co-energy and determine the dynamic model of a DC Machine
- CO 3:Determine the dynamic model of an induction machine based on the dq transformation and determine instantaneous torque developed in an induction machine-which leads to advanced control strategies such as vector control and direct torque control.

TEXT BOOKS:

- 1. Generalized Theory of Electrical Machines P.S.Bimbra, 5 thEdition, Khanna Publications, 1995.
- 2. Electric Motor Drives Modeling, Ana lysis & Control, R. Krishnan PHI Learning Private Ltd, 2009.

REFERENCE BOOKS:

- 1. Analysis of Electrical Machinery and Drive Systems P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff,2ndEdition, Wiley(India),2010.
- 2. Power System Analysis Arthur R Bergen and Vijay Vittal 2nd Edition, Pearson, 2009.
- 3. Power System Stability and Control PrabhaKundur TMH, 2010.
- 4. **Dynamic Simulation of Electric Machin ery using Matlab / Simulink** Chee-MunOng Prentice Hall, 1998.

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 2 and Unit 5.

| AND RETITUTE OF 12 | Subject title : | | | TECHNOLOGY | |
|--|---|--|--|---|--------------------|
| | Subject Code: EPE253 | No. of Cro 4:0:0:0 | edits : | No. of lecture hours/weel | k: 4 |
| Auted By Covt. of Ramataka | Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hour | rs: 52 |
| Adv Vari Char | ojective: To enable students to antages of EVs. ous drive trains acteristics of various types of ba | | | | |
| 4. Conc Unit No. | ept of hybrid electric vehicles | Syllabus o | content | | No. of hours |
| im sta 1 El | troduction to electric vehic pacts. EVmarket and promo indardization. ectric vehicle (EV) design o ngle- vs. multiple-motor drive | otion: infrastr | on figurations | legislation and regulation, s: fixed vs. variable gearing, | 10 |
| 2 proproved action of the second seco | rformance specifications. Clotection. ehicle dynamics and motor celeration and grade. EV driv ives, induction motor drives, j | drives: Road ve train and c permanent-m | l load: vehicle omponents. E | kinetics; effect of velocity, V motor drive systems: DC | 10 |
| Ba 3 tes | atteries: Battery parameters sting and maintenance; char ccuit voltage and ampere- hou | . Types and ging schemes | s. Battery mo | nitoring techniques. Open- | 10 |
| E | nerging EV technologies: odes, torque coordination and | Hybrid elec | ctric vehicles | (HEVs): types, operating | 10 |
| | tel cell electric vehicles (FE) formers. Alternative sources | | | | 10 |
| CC CC CC CC CC CC TEXT B 1. M | | on of a typical erent drive tra as and advant arging variou <u>ve trains of hy</u> chnology- C. | l electric vehic iins. ages of variou is types of batt brid electric v | ele Is battery chemistries. teries. | Press, |

REFERENCE BOOKS:

- 4. **Modern Electric, Hybrid Electric, and Fuel C ell Vehicles:** Fundamentals, Theory and Design- M. Ehsani, Y. Gao, S .E. Gay and A. Emadi, New York: CRC Press
- 5. Web address- Batteryuniversity.com

Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 1 and Unit 3.

| and matrice | Subject title : HVDC POWER TRANSMISSION | | | | | |
|-------------------|---|--|--|--|---|--------------------|
| | | Subject Code: EPE41 | No. of Cree 4:0:0:0 | dits: | No. of lecture hours/wee | ek: 4 |
| Auted By Gave, of | Ramataka | Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hou 52 | rs: |
| Cour • • | DC rea Th and <mark>Th</mark> Th | bjective: In this course, stuc C power transmission and the b active power demanded by the e types of filters and the charace d different methods of control e design techniques for the ma e protection of HVDC syst nsmission and the recent trend | asic componen converter and cteristics of the of HVDC con in components em and othe | the methods for e system imper- verter and system s of an HVDC r converter c | or simulation of HVDC system dance resulting from AC filter tem. system. | ms. designs |
| Unit No. | | | Syllabus co | ontent | | No. of hours |
| 1 | appl tran HV cont with cont four | DC Power Transmission Technology: Introduction, comparison with AC transmission, application of DC transmission, description of DC transmission system, Planning of HVDC transmission, modern trends in DC transmission, operating problems.HVDC Converters: Introduction to Line commutated converter, choice of converter configuration for any pulse number, analysis of 6 and 12 pulse Graetz bridge converter without overlap, effect of smoothing reactor. Two and Three level voltage source converters, Pulse Width Modulation. Analysis of converter in two and three, and three and four valve conduction modes, LCC bridge characteristics, Twelve pulse converter, detailed analysis of converters. Analysis of Capacitor Commutated and voltage source converters. | | | | |
| 2 | chan stop chan volt Con over | Control of Converters and HVDC link: DC link control principles, converter control characteristics, firing angle control, current and extinction angle control, Starting and stopping of Dc link, Power control, Frequency control, Reactive power control, Tap changer control, Emergency control and Telecommunication requirements. Control of voltage source converter. Converter Faults and Protection: Converter faults, protection against over currents, over voltages in converter station, surge arrestor, protection against over voltages. Protection against faults in voltage source converter. | | | 10 | |
| 3 | Converter Configurations for HVDC Transmission: Introduction, Voltage Source Converter (VSC), CCC and CSCC HVDC System, 10.4 Multi-Terminal DC Transmission. Trends for HVDC Applications: Wind Farm Technology, Modern Voltage Source Converter (VSC) HVDC Systems, 800 kV HVDC System. | | | 10 | | |
| 4 | filte Pow proc | monics and Filters: Introductrs. ver Flow Analysis in AC/D cedure, inclusion of constraint trol, power flow analysis und DC system. | C Systems: s, case study, | Introduction, on line powe | dc system model, solution or flow analysis for security | 10 |
| 5 | mod stab | bility Analysis and Power M lulation, practical consideratio ility, analysis of voltage stabil lti Terminal DC Systems: Int | ns in the appl ity in asynchro | ication of moonous AC/DC | dulation controllers, voltage system. | 10 |

| | Course outcomes: | | | | | | |
|---|--|--|--|--|--|--|--|
| | At the end of the course the student will be able to: | | | | | | |
| | • Explain the importance of DC power transmission, the basic components of a converter and methods for compensating the reactive power. | | | | | | |
| Explain the methods for simulation of HVDC systems and its control. | | | | | | | |
| | Design filters for eliminating harmonics. | | | | | | |
| | Explain the design techniques for the main components of an HVDC system. | | | | | | |
| | Analyse the protection of HVDC system and other converter configurations used | | | | | | |
| | for the HVDC transmission. | | | | | | |
| | Describe the recent trends for HVDC applications. | | | | | | |
| | | | | | | | |
| 2. 3. 4. 5. 6. | K. R. Padiyar, "HVDC Power Transmission Systems", New Age International, 2012. E.W.Kimbark "Direct Current Transmission", Vol.1, Wiley Inter-Science, London, 2006. Arrilaga, "High Voltage Direct Current Transmission", The Institute of Engineering Technology, 2 nd Edition, 2007. S Kamakshaiah and V Kamaraju, "HVDC Transmission", TMH, 2011. Vijay K Sood, "HVDC and FACTs Controllers; Applications of Static Converters in Pow Systems, BSP Books Pvt.Ltd.,First Indian reprint 2013. | | | | | | |
| | Systems, Dor Dooks I vi. Ltd., i not indian reprint 2013. | | | | | | |
| 1. | Systems, Dor Dooks i vi. Etd., i nat indian reprint 2013. | | | | | | |
| | One question of 20 marks from each unit. Internal Choices must be provided in | | | | | | |

| State Matrice | Co House | Subject title : MPPT IN SOLAR SYSTEMS | | | | | | |
|------------------|--|--|--|---|--|----------|--|--|
| | | Subject Code: EPE421 | No. of Credits :No. of lecture hours4:0:0:0 | | No. of lecture hours/we | ek: 4 | | |
| Autod By Govt. o | Millian (197 | Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hou 52 | irs: | | |
| Cour | se ob | bjective: In this course, stud | ents learn | |] | | | |
| • | Di no Di | V cell, its characteristics and its fferent methods of tracking ma ise. stributed Maximum Power Pot the design of high energy efficie | aximum power | r point and effe f PV arrays an | ect of noise on MPPT and redu d its analysis. | | | |
| I Init | | | | | | No. | | |
| Unit No. | | Syllabus content PV Modelling: From the Photovoltaic Cell to the Field. The Electrical Characteristic of a | | | | | | |
| 1 | PV Modelling: From the Photovoltaic Cell to the Field, The Electrical Characteristic of a PV Module, The Double-Diode and Single-Diode Models, From Data Sheet Values to Model Parameters, Example: PV Module Equivalent Circuit Parameters Calculation, The Lambert W Function for Modelling a PV Field, Example. Maximum Power Point Tracking: The Dynamic Optimization Problem, Fractional Open-Circuit Voltage and Short-Circuit Current, Soft Computing Methods, The Perturb and Observe Approach. | | | | | | | |
| 2 | Maximum Power Point Tracking (continued): Improvements of the P&O Algorithm, Evolution of the Perturbative Method, PV MPPT via Output Parameters, MPPT Efficiency. MPPT Efficiency: Noise Sources and Methods for Reducing their Effects: Low-Frequency Disturbances in Single-Phase Applications, Instability of the Current-Based MPPT Algorithms, Sliding Mode in PV System, Analysis of the MPPT Performances in a Noisy Environment, Numerical Example. | | | | | | | |
| 3 | Distributed Maximum Power Point Tracking of Photovoltaic Arrays: Limitations of Standard MPPT, A New Approach: Distributed MPPT, DC Analysis of a PV Array with DMPPT, Optimal Operating Range of the DC Inverter Input Voltage. | | | | | | | |
| 4 | Distributed Maximum Power Point Tracking of Photovoltaic Arrays (continued): AC Analysis of a PV Array with DMPPT. | | | | | | | |
| 5 | Design of High-Energy-Efficiency Power Converters for PV MPPT Applications: Introduction, Power, Energy, Efficiency, Energy Harvesting in PV Plant Using DMPPT Power Converters, Losses in Power Converters, Losses in the Synchronous FET Switching Cells, Conduction Losses, Switching Losses. | | | | | | | |
| | | itcomes: | | | | | | |
| At the | Ex cal De Ex Ex Co | of the course the student will b plain the PV cell characteri lculations. escribe different methods of tra plain the sources of noise, effe plain Distributed Maximum P onduct DC and AC analysis of plement high energy efficience | istics and its acking maximu ect of noise on ower Point Tr PV array with | um power poin MPPT and rea acking of PV a DMPPT. | nt. duction of noise. nrrays. | arameter | | |
| | | OK: 1. Nicola Femia et al "Po in Photovoltaic systems" CRC | | es and Control | Techniques for Maximum end | ergy | | |
| | Note: One question of 20 marks from each unit. Internal Choices must be provided in Unit 1 and Unit 2. | | | | | | | |

| Add Ip for of Restate | | Subject Code: EPE422No. of Credits : 4:0:0:0No. | | No. of lecture hours/we | eek: 4 | |
|-----------------------|--|---|--|-------------------------|-----------------------------------|------------|
| | | Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hours: 52 | |
| Cours • • • | AC Dir Co Dy | jective: In this course, stud C/DC and DC/AC Power Conv fferent PWM Techniques imputation of switching Losse mamic Modelling of PWM con fferent compensation techniqu | version s. <mark>nverters</mark>) | | | |
| Unit No. | Syllabus content | | | | | |
| 1 | AC/DC and DC/AC Power Conversion: Overview of applications of voltage source converters. | | | | | |
| 2 | PWM Techniques: Pulse modulation techniques for I – phase bridges, bus clamping PWM, space vector based PWM, advanced PWM techniques. | | | | | 10 |
| 3 | Loss Calculations: Practical devices in converters, calculation of switching and conduction losses, compensation for dead time and DC voltage regulation. | | | | | 12 |
| 4 | Modelling: Dynamic model of PWM converters; constant V/F induction motor drives; estimation of current ripple and torque ripple in inverter fed drives. | | | | | |
| 5 | | verters with Compensations | | | | 10 |
| | end c Ex An Co Im | Atcomes: of the course the student will b plain the applications of AC/I alyse different PWM Techniq impute switching and conduction plement dynamic modeling of scuss different compensation t | OC and DC/AC ues on losses. `PWM conver | | ersion. | |
| 1. M 20 2. En | lohan)1 1. ricksc | CE BOOKS: , Undeland and Robbins, "Pow on RW, "Fundamentals of Pow Vithyathil, "Power Electronic | ver Electronics | ", C hapman I | Hall, 1997. | ley India, |
| Note | : On | e question of 20 marks fro | om each unit 3 and U | | hoices must be provided | in Unit |

| Subject title : DSP APPLICATIONS TO DRIVES | | | | | | | |
|--|--|-------------------------------|-----------------------------|------------|-----------------------------------|-----------------|--|
| And Friday of American | | Subject Code: EPE423 | No. of Credits : 4:0:0:0 | | No. of lecture hours/week : 4 | | |
| | | Exam Duration : 3 hours | CIE : 30 | SEE : 70 | Total No. of lecture hours: 52 | | |
| Cour | se ob | jective: In this course, stud | lents learn | | | | |
| DSP controller, CPU architecture and instruction set. DSP-Based Applications. DSP-based vector control of induction motors. | | | | | | | |
| Unit No. | Syllabus content | | | | | | |
| 1 | Introduction: To the TMS320LF2407 DSP Controller, C2xx DSP CPU architecture and instruction set. General Purpose Input/output (GPIO) functionality interrupts on the TMS320LF2407. | | | | | hours 10 | |
| 2 | Analog-to-Digital Converter (ADC), event managers (EVA, EVB). DSP-Based Applications: Of DC-DC buck-boost converters, DSP based control of stepper motors, | | | | | | |
| 3 | DSP-Based control of permanent magnet brushless DC machines, Park and Clarke's transformations. | | | | | | |
| 4 | Space Vector Pulse Width Modulation, DSP-based control of permanent magnet synchronous machines. | | | | | 10 | |
| 5 | DSI | P-based vector control of ind | luction motor | S . | | 10 | |
| | Course outcomes: At the end of the course the student will be able to: Explain DSP controller, CPU architecture and to write instruction set for specific task. Implement DSP for specific Applications. Implement DSP-based vector control of induction motors. | | | | | | |
| REFE | EREN | CE BOOKS | | | | | |
| 1. Hamid Toliyat and Steven Campbell, "DSP-Based Electromechanical Motion Control", CRC Press, 2011. | | | | | | | |
| P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive Systems", 2nd Edition, Wiley India, 2010 | | | | | | | |
| Chee-Mun Ong, "Dynamic Simulation of Electric Machinery using Matlab / Simulink", Prentice Hall,1998. | | | | | | | |
| Note | : On | e question of 20 marks fro | m each unit 2 and U | | hoices must be provided i | in Unit | |