M.Tech – Power Electronics

Scheme and Syllabus

Department of Electrical & Electronics Engineering

2015-16
## I Semester

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Code</th>
<th>Subject</th>
<th>L-T-P</th>
<th>Credits</th>
<th>CIE</th>
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<td>1.</td>
<td>15EPE101</td>
<td>Applied Mathematics</td>
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<td>Power Semiconductor Devices</td>
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<td>Modeling and Simulation of Power Electronic Systems</td>
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<td>Embedded System Design</td>
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<td>15EPE201</td>
<td>AC and DC Drives</td>
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<td>15EPE213</td>
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<td>15EPE222</td>
<td>Power Electronics For Renewable Energy Systems</td>
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<td>15EPE223</td>
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<tr>
<td>1.</td>
<td>15EPE301</td>
<td>Internship / Mini Project</td>
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**Note:**
1. 15EPE301 – Industrial Internship / Mini Project – To be evaluated after 8 weeks from the date of commencement of 3rd semester. Evaluation – 50 (Report) + 50 (Presentation)
2. 15EPE302 - The students give a minimum of two seminars on the progress of the project. The Department Committee (with guide as one of the member) accesses the progress of the work and the final assessment of Report and presentation will be done at the end of 3rd semester for 100 Marks each respectively.

### IV Semester

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<td>Report Submission, Evaluation &amp; Viva-voce</td>
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**Total** 400
MAT101 APPLIED MATHEMATICS

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UNIT-I

**Numerical Methods:** Solution of algebraic and transcendental equations iterative methods based on second degree equation – Muller method (no derivation) Chebyshev method, general iteration method (first order), acceleration of convergence, system of non-linear equations and complex roots – Newton-Raphson method, polynomial equations – Birge - Vieta method and Bairstow’s method.

8+5Hours

UNIT-II

**Numerical Solution of Partial Differential Equations:** Classification of second order equations, parabolic equations - solution of one dimensional heat equation, explicit method, Crank-Nicolson method and Du Fort-Frankel method, hyperbolic equations - solution of one dimensional wave equation.


7+6Hours

UNIT-III

**System of Linear Algebraic Equations and Eigen Value Problems:** Iterative methods - Gauss-Seidal method, SOR method, Eigen value problems – Gerschgorian circle, Eigen values and Eigen vectors of real symmetric matrices - Jacobi method, Givens method.

**Interpolation:** Hermite interpolation, spline interpolation.

8+5Hours

UNIT-IV

**Optimization:** Linear programming- formulation of the problem, graphical method, general linear programming problem, simplex method, artificial variable technique - M-method.

**Graph Theory:** Basic terminologies, types of graphs, sub graphs, graphs isomorphism, connected graphs-walks, paths, circuits, connected and disconnected graphs, operations on graphs, Eulerian paths and circuits, Hamiltonian paths and circuits, applications of graphs.

8+5Hours

UNIT-V

**Linear Algebra:** Vector spaces, linear dependent, independence, basis and dimension, elementary properties, examples.

**Linear Transformations:** Definition, properties, range and null space, rank and nullity, algebra of linear transformations- invertible, singular and nonsingular transformations, representation of transformations by matrices.

8+5Hours

REFERENCE BOOKS

5. NarsinghDeo, "Graph Theory with Applications to Engineering and Computer Science", PHI, 2012.
**UNIT - I**

**Power Diodes:** on-state losses, switching characteristics-turn-on transient, turn-off transient and reverse recovery transient, Schottky diodes, snubber requirements for diodes, diode snubber, modeling and simulation of power diodes.

**Power BJT’S:** on state losses, switching characteristics, resistive switching specifications, clamped inductive switching specifications, turn-on transient, turn-off transient, storage time, base drive requirements, switching losses, device protection- snubber requirements for BJT’S and snubber design - switching aids, modeling and simulation of power BJT’S.

**Thyristors:**- switching characteristics, turn-on transient and di/dt limitations, turnoff transient, turn-off time and reapplied dv/dt limitations, gate drive requirements, ratings of thyristors, snubber requirements and snubber design, modeling and simulation of thyristors.  

*12 Hours*

**UNIT-II**

**Triacs:** Basic structure and operation-I characteristics, ratings, snubber requirements, modeling and simulation of triacs.  

*4 Hours*

**Gate Turnoff Thyristor (GTO):** Basic structure and operation, GTO switching characteristics, GTO turn-on transient, GTO turn -off transient, minimum on and off state times, gate drive requirements, maximum controllable anode current, overcurrent protection of GTO’S, modelling and simulation of GTO’S.  

*6 Hours*

**UNIT-III**

**Power MOSFET’S:**- Basic structure, V-I characteristics, turn-on process, on state operation, turn-off process, switching characteristics, resistive switching specifications, clamped inductive switching specifications - turn-on transient and di/dt limitations, turn-off transient, turn off time, switching losses, effect of reverse recovery transients on switching stresses and losses - dv/dt limitations, gating requirements, gate charge - ratings of MOSFET’S, FBSOA and RBSOA curves, device protection -snubber requirements, modeling and simulation of Power MOSFET’S. MOSFET drivers and protection, Miller region.  

*10 Hours*

**UNIT-IV**

**Insulated Gate Bipolar Transistors (IGBT’S):** Basic structure and operation, latch up IGBT, switching characteristics, resistive switching specifications, clamped inductive switching specifications - IGBT turn-on transient, IGBT turn off transient- current tailing - gating requirements -ratings of IGBT’S, FBSOA and RBSOA curves, switching losses - minimum on and off state times - switching frequency capability - over current protection of IGBT’S, short circuit protection, snubber requirements and snubber design. IGBT drivers and protection, Active clamping  

*10 Hours*

**UNIT-V**

**New Power Semiconductor Devices :**MOS gated thyristors, MOS controlled thyristors or MOS GTO’S, base resistance controlled thyristors, emitter switched thyristor, GaN and SiC devices

Thermal design of power electronic equipment, modelling and simulation, heat transfer by conduction, transient thermal impedance - heat sinks, heat transfer by radiation and convection - heat sink selection for power semiconductor devices.  

*10 Hours*
REFERENCE BOOKS
15EPE103  MODELING AND SIMULATION OF POWER ELECTRONIC SYSTEMS

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**Unit - I**

**Computer Simulation of Power Electronic Converters and Systems**: Challenges in computer simulation, simulation process, Types of analysis, mechanics of simulation, circuit-oriented simulators, equation solvers, comparison of circuit oriented simulators and equation solvers.

**Modeling of Systems**: Input-Output relations, differential equations and linearization, state space representation, transfer function representation, modeling of an armature controlled DC Motor, poles and zeros.  

**8+5 Hours**

**Unit - II**

Circuit averaging method of modeling approach for switched power electronic circuits, Space vector modeling: representation of space vectors in orthogonal co-ordinates, space vector transformations, Modeling of induction motor, state space representation of the d-q model of the induction motor.  

**8+5 Hours**

**Unit - III**

**Digital Controller Design**: Controller design techniques, Bode diagram method, PID controller, design, Root locus method  

**7+6 Hours**

**Unit - IV**

State space method, regulator design by pole placement, estimator design, tracker, controller design, controlling voltage, controlling current.  

**8+5 Hours**

**Unit - V**

**Discrete Computation Essentials**: Numeric formats, fixed -point numeric format, floating -point numeric format, tracking the base point in the fixed point system, addition of numbers, subtraction of numbers, multiplication of numbers, normalization and scaling, multiplication algorithm, arithmetic algorithm reciprocal, square root, reciprocal of square root, sine and cosine exponential, logarithm, implementation examples, pi controller, sine and cosine, pulse width modulation, space vector pwm, over-modulation.  

**8+5 Hours**

**REFERENCE BOOKS**

**15EPE104**  SOLID STATE POWER CONTROLLERS

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**UNIT-I**

**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.  

**UNIT-II**

**Inverters:** Principle of operation, performance parameters, single phase bridge inverters and three phase inverters.

**UNIT-III**

**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.

**UNIT-IV**

**Multilevel Inverters:** Introduction, types, diode clamped multi-level inverters, features & applications.

**UNIT-V**

**DC-DC Converters:** Principle of operation, analysis of step-down and step-up converters, classification of chopper & chopper circuit design.

**REFERENCE BOOKS**

<table>
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<tr>
<th>15EPE105</th>
<th>SWITCHED MODE POWER SUPPLY</th>
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**Unit - I**

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, 11 Hours

**Unit - II**

Principle of operation and analysis of buck-boost converter analysis, inductors current ripple and output voltage ripple, design considerations, 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), 10 Hours

**Unit - III**

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, 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 Hours

**Unit - IV**

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 resonant DC-DC converter, resonant converters comparison, resonant DC link converter, 10 Hours

**Unit - V**

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.

Design of inductor and transformers for SMPC, 11 Hours

**REFERENCE BOOKS**

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1. Analysis of static and dynamic characteristic of MOSFET and IGBT
2. Modeling and Simulation of Power Semiconductor Devices (Any 2 Experiments)
3. Performance of single phase fully controlled and semi-controlled converter for RL load for continuous current mode
4. Performance of single phase fully controlled and semi-controlled converter for RL load for discontinuous current mode
5. Study of effect of source inductance on the performance of single phase fully controlled converter
6. Performance analysis of three phase fully controlled and semi-controlled converter for RL load for continuous current mode
7. Performance analysis of three phase fully controlled and semi-controlled converter for RL load for discontinuous current mode
8. Performance analysis of single phase bridge inverter for RL load and voltage control by single pulse width modulation
9. Performance analysis of two quadrant chopper
10. Modeling and Simulation of SMPS circuits (Any 2 Experiments)
EMBEDDED SYSTEM DESIGN  

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**Unit I**

**Introduction:** Embedded systems overview-design challenge-optimizing metrics-processor technology-IC technology- design technology- automation- synthesis- verification: hardware/software co simulation-trade-offs.  
8 Hours

**Unit II**

**Processing Elements:** Custom single purpose processor design-RT level custom single purpose processor design-optimizing custom single purpose processors-General purpose processor's software: architecture, operation, programmer’s view and development environment – ASIPs - selecting a microprocessor - general purpose processor design.  
8 Hours

**Unit III**

**Memory:** Introduction-memory write ability and storage Permanence-common memory types-composing memory-memory hierarchy and caches-advanced RAM.  
7 Hours

**Unit IV**

**Interfacing:** Introduction-communication basics-microprocessor interfacing: I/O addressing, interrupts, DMA-Arbitation-multilevel bus architectures-advanced communication principles-serial protocols-parallel protocols-wireless protocols-Standard single purpose processor's peripherals: timers, counters, watchdog timers, UART, PWM, LCD controllers, keypad controllers, stepper motor controllers, ADC and RTC.  
8 Hours

**Unit V**

**RTOS:** Principles of RTOS, Task, Task Scheduling, Semaphore, Priorities  
Case Study: Digital Camera Example, Tank level monitor using RTOS  
8 Hours

**Textbook**

2. Embedded System Premier, David E Simon, Addison Wesley  

**References**

2. Santanuchattopadhyay, Embedded system Design, PHI Learning Pvt. Ltd., 2010  
15EPE112 | SOFT COMPUTING

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No. of Hours/Week (L-T-P): 3-0-0  Exam Hours: 03
Total No. of Hours: 39  Exam Marks: 100

**UNIT – 1**

**Soft Computing:** Introduction, difference between conventional and soft computing, main components of soft computing: history and basic principles

**Artificial neural network:** structure of neuron, neural network architectures, examples

**Single layer networks:** Perceptron, Adaptive linear neuron (Adaline), and the LMS algorithm 07 Hours

**UNIT – 2**

**Associative Memory Networks:** Training algorithm for pattern association, Auto, Hetero, Bidirectional Associative Network, Hopfield Network, Interactive Auto associative, Temporal Associative Network 04 Hours

**Multilayer and unsupervised networks:** Error back propagation algorithm, winner-take-all networks, Learning vector quantizing, counter propagation networks, adaptive resonance theorem Application of Generalized neuron models. 04 Hours

**UNIT – 3**

**Fuzzy logic:** Fuzzy sets, Properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, the extension principle, Linguistic variables, Fuzzy proportions, Fuzzy if then statements, inference rules, compositional rule of inference. 08 Hours

**UNIT – 4**

**Fuzzy Systems:** Fuzzification and defuzzification procedures, applications of fuzzy logic: washing machine, traffic light controllers, steady and transient DC machine model, fuzzy power system stabilizers 08 Hours

**UNIT – 5**

**Genetic Algorithm:** Simple genetic Algorithms, improved genetic algorithms, limitations of GA, application 06 Hours

**Introduction to Swarm Intelligence Technology** 02 Hours

**REFERENCE BOOKS**

15EPE113 ADVANCED CONTROL SYSTEMS

<table>
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**Unit - I**

**Digital Control Systems**: Review of difference equations and $Z$-transforms, $Z$-transfer function (Pulse transfer function), $Z$-Transforms analysis, sampled data systems  
7 Hours

**Unit - II**

Stability analysis (Jury's Stability Test and Bilinear Transformation), pulse transfer functions and different configurations for closed loop discrete-time control systems.  
8 Hours

**Unit - III**

**Modern Control Theory**: State model for continuous time and discrete time systems, solutions of state equations (for both continuous and discrete systems)  
8 Hours

**Unit - IV**

Concepts of controllability and observability (for both continuous and discrete systems), Pole placement by state feedback (for both continuous and discrete systems), full order and reduced order observes (for both continuous and discrete systems), dead beat control by state feedback,  
8 Hours

**Unit - V**

**Non Linear Control Systems**: Common nonlinearities, singular points, stability of nonlinear systems - phase plane analysis, Lyapunov's stability criterion.  
8 Hours

**REFERENCE BOOKS:**

15EPE201  AC AND DC DRIVES

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**Unit - I**


8+5 Hours

**Unit - II**

**DC Drives:** Single Quadrant Drive: 1-Phase semi and half wave converter drives, Two quadrant drive: 1-phase and 3-phase full converter drive. Two and Four quadrant drive: 1-phase and three-phase dual converter drive, different braking methods and closed loop control of DC drives.

8+5 Hours

**Unit - III**

**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,

7+6 Hours

**Unit - IV**

Voltage and current source inverter fed induction motor drives, stator and rotor voltage control methods, slip energy recovery drives.

**Closed Loop Control of AC Drives:** Stator voltage control V/fcontrol, Slip regulation

8+5 Hours

**Unit - V**

Speed control of static Kramer’s drive and current control.

Brushless DC motor, stepper motor and variable reluctance motor drives, Static excitation schemes of AC generator.

8+5 Hours

**REFERENCE BOOKS**

**UNIT-I**

**Power electronic converters for dc-ac and ac-dc power conversion:** Review of Electronic switches, dc-dc buck and boost converters, H-bridge, multilevel converters. Diode clamp, flying capacitor and cascaded-cell converters; voltage source and current source converters, Overview of applications of voltage source and current source converters, motor drives. 8+5 Hours

**UNIT-II**

**PWM Techniques:** Pulse modulation techniques for Single phase bridges, PWM classification-sinusoidal PWM , selected harmonic elimination PWM, Minimum Ripple Current PWM, Space vector PWM, sinusoidal PWM with instantaneous current control, hysteresis band, current control PWM. 8+5 Hours

**UNIT-III**

**Loss Calculations:** Practical devices in converters, calculation of switching and conduction losses, compensation for dead time and DC voltage regulation. 7+6 Hours

**UNIT-IV**

**Modeling:** Induction motor control with small signal model, scalar control-voltage fed inverter control, open loop V/f control, energy conservation effect by variable frequency drive, speed control with slip regulation, speed control with torque and flux control, current controlled voltage fed inverter drive, Current Fed Inverter control: independent current and frequency control, speed and flux control in current fed inverter drive, V/f control of current fed inverter drive, vector or field oriented control, sensorless vector control. 8+5 Hours

**UNIT-V**

**Converters with Compensation:** Line-side converters with power factor compensation, reactive power compensation, harmonic current compensation. 8+5 Hours

**REFERENCE BOOKS:**

4. V. T. Ranganathan, Course Notes on Electric Drives, Indian Institute of Science, Bangalore 2004
7. Application notes and datasheets from Power Semiconductor Switch manufacturers like Infineon, MuRata
8. Relevant technical papers published.
### HVDC POWER TRANSMISSION

<table>
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</table>

#### UNIT-I

**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.  
**05 Hours**

**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.  
**05 Hours**

#### UNIT-II

**HVDC Converters:** (Contd.) 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.  
**11 Hours**

#### UNIT-III

**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.  
**07 Hours**

**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.  
**04 Hours**

#### UNIT-IV

**Smoothing Reactor and DC line:** Smoothing reactors, Effects of corona loss, DC line insulators, Transient over voltages in DC line, Protection in dc line, Detection and protection of faults, DC breaker

**Reactive Power Control:** Reactive power control in steady state and transient state, sources of reactive power, SVC and STATCOM (Qualitative Approach).  
**Harmonics and Filters:** Introduction, Generation of harmonics, design of AC and DC filters.  
**10 Hours**

#### UNIT-V

**Power Flow Analysis in AC/DC Systems:** Introduction, dc system model, solution procedure, inclusion of constraints, power flow with VSC based HVDC system.

**Stability Analysis and Power Modulation:** Introduction to stability concepts, power modulation, practical considerations in the application of modulation controllers, voltage stability in AC/DC system.

**Multi Terminal DC Systems:** Introduction, applications, types  
**10 Hours**

#### REFERENCE BOOKS

15EPE204  FACTS CONTROLLER

| Credits | 04 |
| No. of Hours/Week (L-T-P) | 4-0-0 |
| Total No. of Hours | 52 |
| Exam Hours | 03 |
| Exam Marks | 100 |

**Unit - I**

**Introduction:** Basics of power transmission networks - control of power flow in AC - transmission line, Transmission, interconnection, power flow and dynamic stability consideration of a transmission interconnection, relative importance of controllable parameters. Classification of flexible AC transmission system controllers, Benefits of FACTS Controller – application of FACTS controllers in distribution systems. 5 Hours

**Static Phase Shifting Transformer:** General - basic principle of a PST - configurations of SPST improvement of transient stability using SPST - damping of low frequency power oscillations - applications of SPST. 5 Hours

**Shunt Compensation:** Objectives of Shunt Compensation, Midpoint voltage regulation for line segmentation, End of line voltage support to prevent voltage instability, Improvement of Transient stability, Power oscillation damping. 4 Hours

**Static Var compensator:** Methods of controllable Var generation, Analysis of SVC - Power angle curve with SVC, Configuration of SVC - FC-TCR, TSC-TCR, SVC Controller – Block diagram of SVC Voltage Controller, Susceptence Regulator, SMC.- voltage regulator design – speed of response as function of ESCR - modeling of SVC – applications of SVC. 8 Hours

**Unit - II**

**Thyristor and GTO Controlled Series Capacitor:** Introduction - basic concepts of controlled series compensation - operation of TCSC - analysis of TCSC- control of TCSC - modeling of TCSC for stability studies – GTO thyristor controlled series capacitor (GCSC) - mitigation of sub synchronous resonance with TCSC and GCSC - applications of TCSC. 10 Hours

**Unit - III**

**Static Synchronous Compensator (STATCOM):** Introduction - principle of operation of STATCOM - a simplified analysis of a three phase six pulse STATCOM - analysis of a six pulse VSC using switching functions - multi-pulse converters.control of type 2 converters - control of type I Converters - multilevel voltage source converters - applications of STATCOM. 10 Hours

**Unit - IV**

**SSSC, UPFC & IPFC:** SSSC-operation of SSSC, control of power flow - Description, modeling of SSSC, control of SSSC using Type-2 and Type-1 VSC, Unified Power Flow Controller (UPFC) – basic operating principle and implementation of Two converter UPFC, modes of operation, conventional transmission control capabilities of UPFC, Interline Power Flow Controller (IPFC) – Basic operating principles. Control scheme of two converter IPFC. 10 Hours

**REFERENCE BOOKS**


REFERENCE BOOKS


**15EPE205**  
**POWER ELECTRONICS SYSTEM DESIGN LABORATORY**

<table>
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* SEE will be conducted as a Laboratory Examination

1. **Effect of Op-amp Non idealities**
   a. Offset voltage, Input resistance, Gain, Bandwidth, CMRR - Inverting and Non-inverting configurations. (2 Experiments)

2. **Commercial PWM Control ICs and their Applications** (Any 3 Experiments)
   a. PWM Control IC
   b. Programmable off line PWM controller
   c. Current mode control IC
   d. Resonant mode power supply controller

3. **Phase – Locked Loops (PLL) & Applications**: (Any 3 Experiments)
   a. PLL Design using ICs
   b. 555 timer & its applications
   c. Analog to Digital converter using IC’s,
   d. Digital to Analog converters using ICs
   e. Implementation of different gating circuits (Task)

4. **Inductor design for SMPS**

5. **Design and implementation of Buck Converter**
The aim of the seminar is to inculcate self-learning, face audience, enhance communication skill, involve in group discussion and present his ideas.

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.

The internal assessment marks shall be awarded by a committee consisting of at least two staff members based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report.
14EPE211 Real Time Digital Signal Processing

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UNIT - 1

INTRODUCTION TO DIGITAL SIGNAL PROCESSING: Introduction, A Digital Signal-Processing System, The Sampling Process, Discrete Time Sequences, Linear Time Invariant, Fourier Transform, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Digital Filters. *(Chapter 2, 4&5 of reference 2 and chapter 2, 4, 5,6,7,8 of reference 1)*

UNIT - 2

ARCHITECTURES FOR PROGRAMMABLE DIGITAL SIGNAL PROCESSORS: Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution *(Chapter 4 of Reference 3)*

UNIT - 3

PROGRAMMABLE DIGITAL SIGNAL PROCESSORS: Introduction, Commercial Digital Signal-processing Devices, DSP Processor Architecture, Addressing Modes of DSP Processor, Pipeline and Parallelism, DSP Processor Instruction set and Programming (Only commonly used instructions for filter programs) *(Chapter 5 of Reference 3)*

UNIT - 4

FIR FILTER DESIGN, COEFFICIENT CALCULATION AND IMPLEMENTATION IN TMS320C54/55

Filter Design: Linear Phase filters: Type I, Type II, Type III, & Type IV. FIR filter design using Impulse Response Truncation: Low pass, High pass filter & Band pass filter, FIR design using window technique, Frequency Sampling method

Filter Implementation: Implementation of block and Symmetry filter *(Chapter 5 of Reference 5 & Chapter 5 of reference 3 for assembly programs)*

UNIT - 5

IIR FILTER DESIGN, COEFFICIENT CALCULATION AND IMPLEMENTATION IN TMS320C54/55


Reference Books:
1. DSP Principles, Algorithm and Applications by John G Proakis, Dimitris G Manolakis
2. Discrete Time Digital Signal Processing by Oppenheim, Schafer and Buck
3. Digital Signal Processing, Avtar Singh & S. Srinivasan
4. Digital signal processing: a practical approach by Emmanuel C. Ifeachor, Barrie W. Jervis
5. Real-Time Digital Signal Processing by Sen M Kuo, Bob H Lee
15EPE212 **MODELING AND ANALYSIS OF ELECTRICAL MACHINES**

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**Unit-I**

**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.

**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. **07 Hours**

**Unit-II**

**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. **07 Hours**

**Unit-III**

**Dynamic Modeling of Three Phase Induction Machine:** Generalized model in arbitrary frame, electromagnetic torque, derivation 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.

**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. **10 Hours**

**Unit-IV**

**Transformer Modeling:** 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. **08 Hours**

**Unit-V**

**Modeling 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. **07 Hours**

**REFERENCE BOOKS**

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
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**Unit - I**

The Smart Grid: Introduction, Information And Communication Technologies: Data communication, Switching techniques, Communication channels, Layered architecture and protocols Communication technologies for the Smart Grid - Communication technologies, Standards for information exchange 8 Hours

**Unit - II**

Information security for the Smart Grid - Introduction, Encryption and decryption, Authentication, Digital signatures, Cyber security standards Sensing, Measurement, Control And Automation Technologies: Smart metering - An overview of the hardware used, Communications infrastructure and protocols for smart metering, Demand-side integration 8 Hours

**Unit - III**

Distribution automation equipment - Introduction, Distribution management systems - Introduction, Data sources and associated external systems, Modelling and analysis tools, Transmission system operation - Phasor measurement units, Wide area applications 8 Hours

**Unit - IV**

Power electronics in the Smart Grid - Introduction, Renewable energy generation, Photovoltaic systems, Wind, hydro and tidal energy systems, Fault current limiting. 8 Hours

**Unit V**

Energy storage - Introduction, Energy storage technologies, Shunt compensator with energy storage, Case study 7 Hours

**Text Book:**

**Reference:**
<table>
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<tr>
<th>15EPE221</th>
<th>POWER QUALITY ENHANCEMENT AND CUSTOM POWER DEVICES</th>
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**Unit - 1**


**Analysis and Conventional Mitigation Methods:** Analysis of Power Outages, Analysis of Unbalance, Analysis of Distortion, Analysis of Voltage Sag, Analysis of Voltage Flicker, Harmonic Reduction, Voltage Sag or Dip Reduction. 8 Hours

**Unit-2**

**Custom Power Devices:** Introduction, Utility-Customer Interface, Custom Power Devices, Custom Power Park, Status of Application of CP Devices.


**Unit-3**

**Load Compensation using DSTATCOM:** Compensating Single-Phase Loads, Ideal Three-Phase Shunt Compensator Structure, Generating Reference Currents Using Instantaneous PQ Theory, Generating reference currents using instantaneous Symmetrical Components. 8 Hours

**Unit-4**

**Realization and Control of DSTATCOM:** DSTATCOM Structure, Control of DSTATCOM Connected to a Stiff Source, DSTATCOM Connected to weak Supply Point, DSTATCOM Current Control through Phasors, DSTATCOM in Voltage Control Mode. 7 Hours

**Unit-5**

**Series Compensation of Power Distribution System:** Rectifier Supported DVR, DC Capacitor Supported DVR, DVR Structure, Voltage Restoration, Series Active Filter.

**Unified Power Quality Conditioner:** UPQC Configurations, Types of UPQC, Right-Shunt UPQC Characteristics, Left-Shunt UPQC Characteristics. 8 Hours

**REFERENCE BOOKS**

**Unit - I**

**Renewable Electrical Systems:** Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems. 

8 Hours

**Unit II**

**ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION:** Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.  

7 Hours

**Unit -III**

**POWER CONVERTERS:** Solar: Block diagram of solar photovoltaic system - Principle of operation: line commutated converters (inversion-mode) - selection of inverter, array sizing Wind: three phase AC voltage controllers- AC-DC-AC converters, Grid Interactive Inverters-matrix converters.

5 Hours

**Energy storage – Introduction**, Energy storage technologies

4 Hours

**Unit - IV**

**ANALYSIS OF WIND AND PV SYSTEMS:** Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS Grid Integrated solar system. 

8 Hours

**Unit - V**

**HYBRID RENEWABLE ENERGY SYSTEMS:** Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT). 

7 Hours

**REFERENCES:**

**Unit- I**

**Introduction:** To the TMS320LF2407 DSP Controller, C2xx DSP CPU architecture and instruction set. General Purpose Input/output (GPIO)  

8 Hours

**Unit - II**

Functionality interrupts on the TMS320LF2407, Analog-to-Digital Converter (ADC), event managers (EVA, EVB).  

8 Hours

**Unit- III**

**DSP-Based Applications:** Of DC-DC buck-boost converters, DSP based control of stepper motors, DSP-Based control of permanent magnet brushless DC machines  

8 Hours

**Unit IV**

Park and Clarke's transformations. Space Vector Pulse Width Modulation,  

7 Hours

**Unit - V**

DSP-based control of permanent magnet synchronous machines. DSP-based vector control of induction motors.  

8 Hours

**REFERENCE BOOKS**

### III Semester M.Tech (PE) (2015-17)

<table>
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<td>15EPE301</td>
<td>Internship / Mini Project</td>
<td>Full time 8 weeks</td>
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<td>15EPE302</td>
<td>Project Phase -1</td>
<td>Full time 8 weeks</td>
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<td>15EPE303</td>
<td>Seminar on special topics</td>
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**Note:**

1. **15EPE301 – Industrial Internship / Mini Project** – To be evaluated after 8 weeks from the date of commencement of 3rd semester. Evaluation: 50 (Report) +50 (Presentation)
2. **15EPE302** - The students give a minimum of two seminars on the progress of the project. The Department Committee (with guide as one of the member) accesses the progress of the work and the final assessment of Report and presentation will be done at the end of 3rd semester for 100 Marks.

### 15EPE303 SEMINAR

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The aim of the seminar is to inculcate self-learning, face audience, enhance communication skill, involve in group discussion and present his ideas.

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) Carry out 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.

The internal assessment marks shall be awarded by a committee consisting of at least two staff members based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report.
### IV Semester M.Tech (PE) (2015-16)

<table>
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<td>Viva-voce</td>
<td>400</td>
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<td>Report Submission, Evaluation &amp; Viva-voce</td>
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|     | Total  |                                 |         | 30      | 100  |       | 300        |
|     |        |                                 |         |         |      |       | 400        |

1. **15EPE401**: CIE will be awarded by the Department Committee for 100 marks. The project report will be evaluated by the Guide and the external examiner for 100 marks each. Viva-Voce will carry 100 marks and will be conducted by a committee consisting of the following:

   (a) Chairman, BOE (PG)
   (b) Project Guide
   (c) External Examiner