M. Tech: POWER ELECTRONICS

Department of Electrical & Electronics Engg.

B M S College of Engineering

Scheme & Syllabus

2018-2019

PROGRAM OUTCOMES: JULY 2018 (Defined by NBA)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PROGRAM EDUCATIONAL OBJECTIVES

Graduates of the M. Tech Power Electronics Program will,

1. Excel professionally in Power Electronics and allied domains.

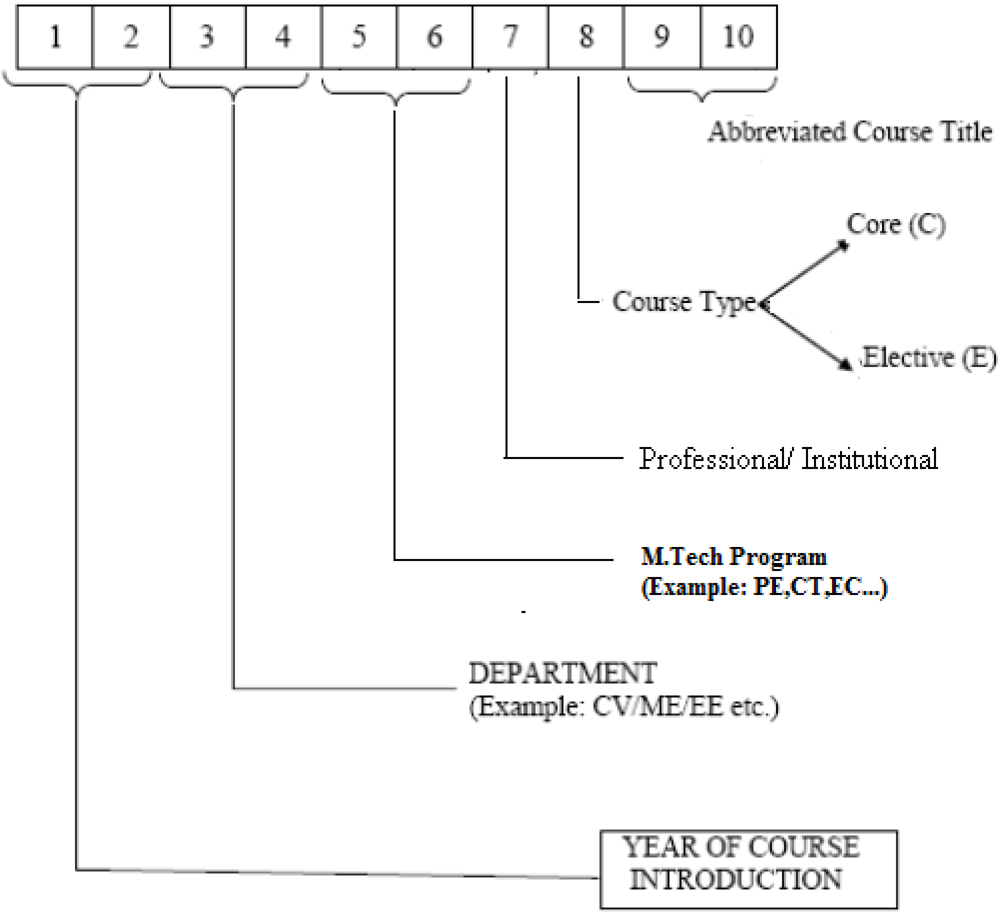
2. Undertake research and development that addresses technological requirements of Industry and Institutes of higher learning.

3. Adapt to the changing needs of Industry/Society through lifelong learning.

CREDIT SUMMARY

Sem.	PCC	PEC	ICC	IEC	Internship	Project phase I / Final Project	Technical Seminar	Total
I	14	6	2	-	-	-	-	**22**
II	12	6	-	4	-	-	-	**22**
III	-	4	-	-	-	8	-	**22**
IV	-	-	-	-	10	20	2	**22**
Total	**26**	**16**	**2**	**4**	**10**	**28**	2	**88**

NOMENCLATURE FOR THE COURSE CODE



I Semester

Course Type	Code	Course Title	Credits				Marks		
			L	T	P	Total Credits	CIE	SEE	Total
Program Core-1	18EEPEBSMT	Applied Mathematics	3	0	0	3	50	50	100
Program Core-2	18EEPEPCPS	Power Semiconductor Devices	3	0	0	3	50	50	100
Program Core-3	18EEPEPCSP	Solid State Power Controllers	3	0	1	4	50	50	100
Program Core-4	18EEPEPCMS	Modeling & Simulation of Power Electronics Systems	3	0	1	4	50	50	100
Program Elective-1	18EEPEPEDM	Digital Measurements	3	0	0	3	50	50	100
	18EEPEPEMA	Modeling & Analysis of Electrical Machines							
	18EEPEPEPS	Power Electronics in Smart Grid							
Program Elective-2	18EEPEPEES	Embedded System Design	3	0	0	3	50	50	100
	18EEPEPECV	CMOS VLSI Design and system on chip							
	18EEPEPEAC	Advanced Control System							
Institution Core	18HSMCICRM	Research Methodology and IPR	2	0	0	2	50	50	100
	TOTAL		**20**	**0**	**2**	**22**	**350**	**350**	**700**

II Semester

Course Type	Code	Course Title	Credits				Marks		
			L	T	P	Total Credits	CIE	SEE	Total
Program Core-5	18EEPEPCAD	AC-DC Drives	3	0	1	4	50	50	100
Program Core-6	18EEPEPCSM	Switched Mode Power Conversion	3	0	1	4	50	50	100
Program Core-7	18EEPEPCFC	FACTs Controllers in Power Transmission and Distribution	3	1	0	4	50	50	100
Program Elective-3	18EEPEPEPD	Power Electronics System Design using ICs	3	0	0	3	50	50	100
	18EEPEPEHV	HVDC Transmission Systems							
	18EEPEPEPW	PWM Converters & Applications							
Program Elective-4	18EEPEPEPC	Power Quality Enhancement using Custom Power Devices	3	0	0	3	50	50	100
	18EEPEPEEM	Electro Magnetic Compatibility							
	18EEPEPEEV	Electric Vehicles							
Institution Elective – 1 (Engineering)	18EEPEIERE	Renewable Energy & Photovoltaics	4	0	0	4	50	50	100
	18EEPEIEMS	Micro & Smart Systems							
	TOTAL		**19**	**1**	**2**	**22**	**300**	**300**	**600**

III Semester

Course Type	Code	Course Title	Credits			Total Credits	Marks		
			L	T	P		CIE	SEE	Total
Program Core-8	18EEPEPCIN	Internship	0	0	10	10	50	50	100
Program Core-9	18EEPEPCP1	Project Phase - I	0	0	08	08	50	50	100
Program Elective-5	18EEPEPEXX	Industrial Safety Cost Management of Engineering Projects DSP Applications to Drives	4	0	0	4	50	50	100
	TOTAL		**4**	**0**	**18**	**22**	**150**	**150**	**300**

IV Semester

Course Type	Code	Course Title	Credits			Total Credits	Marks		
			L	T	P		CIE	SEE	Total
Program Core-10	18EEPEPCP2	Project Work (Final Phase)	0	0	20	20	50	50	100
Program Core-11	18EEPEPCTS	Technical Seminar	0	0	02	02	50	50	100
	TOTAL		**0**	**0**	**22**	**22**	**100**	**100**	**200**

Percentage compliance to AICTE Model: 55 % (Core + Elective courses + IC+ IE)
: 45 % (Internship + Project work + T. Seminar)

Percentage compliance to VTU Curriculum:

VTU curriculum structure:

: 57% (Core +Elective courses)

: 43% (Internship+Projects+Seminar)

	Core courses	Elective courses	ICC	IEC	Seminar	Internship	Project	Total credits	% Core (Core+ICC)	% Elective (Elective + IEC)	% Project + Internship + Seminar
VTU syllabus	40	09	--	--	02	20	14	85	**47%**	**10%**	**43%**
Autonomous	26	16	02	04	--	11	29	88	**32%**	**23%**	**45%**

The percentage core courses in VTU curriculum is comparatively higher with respect to autonomous curriculum. Percentage of Elective courses offered in proposed PG curriculum is comparatively higher with respect to VTU curriculum to provide an opportunity for students to select elective courses based on their area of interest.

The overall percentage for internship and project for both curriculum is almost same.

Contribution from other departments : Mathematics (3-0-0)
MBA (4-0-0)

CO-PO Mapping Summary table for M. Tech Power Electronics Courses (with Strength of Mapping)

COURSE TITLE	PO1	PO2	PO3
Applied Mathematics			* 3
Power Semiconductor Devices		* 1	* 3
Solid State Power Controllers		* 1	* 3
Modeling & Simulation of Power Electronics Systems		* 1	* 3
Power Electronics in Smart Grid		* 1	* 3
Embedded System Design		* 1	* 3
CMOS VLSI design and system on chip			* 3
Research Methodology and IPR		* 1	* 3
AC-DC Drives		* 1	* 3
Switched Mode Power Conversion		*1	* 3
FACTs Controllers		* 1	* 3
Power Electronics System Design using ICs		* 1	* 3
Power Quality Enhancement using Custom Power Devices			* 3
HVDC Transmission Systems			* 3
Electro Magnetic Compatibility			* 3
DSP Applications to drives			*3
Renewable Energy & Photovoltaics			* 3
Micro & Smart Systems			* 3
Electric Vehicles		* 1	* 3
Industrial Safety			* 3
Cost Management of Engineering Projects			* 3
Internship	* 1	* 2	* 3
Technical Seminar	* 1	* 2	* 3
Project Phase I	* 1	* 2	* 3
Project Work (Final Phase)	* 2	* 2	* 3

SYLLABUS

I SEMESTER

Subject	APPLIED MATHEMATICS	Sub-code	18EEPEPCMT
Credits	03	L-T-P	3-0-0

Course Outcomes:
CO1: Apply the concepts of solving polynomial equations, transcendental equations, ordinary differential equations, partial differential equations, system of algebraic equations, non-linear equations, and ordinary differential equations for Engineering problems.

CO2: Apply the concepts of graph theory, eigen value problems, interpolation and linear algebra to deal with projects.

Unit 1: Numerical Methods: Solution of algebraic and transcendental equations: iterative methods based on second degree equation–Muller method, Chebyshev method, general iteration method, acceleration of convergence, system of non-linear equations, and complex roots – Newton-Raphson method, system of ordinary differential equations , Numerov method. Polynomial equations:Birge – Vieta method and Bairstow's method.

Unit 2: 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.

Unit 3: System of Linear Algebraic Equations: Iterative methods - Gauss-Seidal method, Relaxation method, **Eigen value problems**: Eigen values and Eigen vectors of real symmetric matrices - Jacobi method, Givens method. **Interpolation:** Hermite interpolation, spline interpolation.

Unit 4: 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.

Unit 5: 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 non-singular transformations, representation of transformations by matrices.

REFERENCE BOOKS:

1. M K Jain, S R K Iyengar and R K Jain, "Numerical Me thods for Scientific and Engineering Computations", New Age International Publications, 6th Edition, 2012.
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2013,
3. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", PHI, 2012.
4. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2 ndEdition, PHI, 2011
5. Steven C. Chapra and Raymond Canale, "Numerical methods for Engineers", McGraw-Hill Education, 7th Edition, 2014.
6. David C. Lay, "Linear Algebra and its applications", 3rd Edition, Pearson Education, 2002.

Subject	POWER SEMICONDUCTOR DEVICES	Sub-code	18EEPEPCPS
Credits	03	L-T-P	3-0-0

Course outcomes:

CO1: Apply knowledge of physics of semiconductor and electronic devices to develop and control power electronic systems.

CO2: Describe, analyze characteristics and compare various types of power semiconductor devices for theoretical and practical context.

CO3: Identify and prioritize the use of power devices in various power electronic systems and control applications.

CO4: Apply the concept of thermal design for various power electronic equipment's.

CO5: Develop skills and apply the principles to explore the possibility of emerging power semiconductor devices in different areas and prepare a technical report.

Unit 1: Power Diodes: Basic Structure and I-V Characteristics. Breakdown Voltages and Control. On State Losses, Switching Characteristics. Turn on Transient. Turn off Transient. Reverse Recovery Transient. Schottky Diodes. Snubber Requirements for Diodes and Diode Snubbers. Modelling and simulation of Power Diodes.

Unit 2: Thyristors:
a)Thyristors: - Basic Structure. V-I Characteristics. Turn on Process. On State operation. Turn off process, Switching Characteristics .Turn on Transient and di/dt limitations. Turn off Transient. Turn off time and dv/dt limitations. Ratings of Thyristors. Snubber Requirements and Snubber Design. Modeling and simulation of Thyristors.
b)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 .Maximum Controllable Anode Current Overcurrent protection of GTOs Modeling and simulation of GTOs.

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Unit 3: Transistors:
a)Power BJTs: . Basic Structure and I-V Characteristics, Switching Characteristics.
b)MOSFETs - 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 MOSFETs. FBSOA and RBSOA Curves. Device Protection -Snubber Requirements. Modelling and simulation of Power MOSFETS.
c)Insulated Gate Bipolar Transistors (IGBTs):. 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. FBSOA and RBSOA Curves. Switching Losses - Minimum ON and OFF State times - Switching Frequency Capability - Overcurrent protection of IGBTs . Short Circuit Protection. Snubber Requirements and Snubber Design.

Unit 4: Thermal design of power electronic equipment:
Heat transfer by conduction, transient thermal impedance - heat sinks .Heat transfer by radiation and convection - Heat Sink Selection for Power Semiconductor Devices

Unit 5: Emerging Trends:
New power semiconductor devices: MOS Gated Thyristors, MOS Controlled Thyristors, emitter turn-off thyristor (ETOs), Integrated Gate Commutated Thyristor (IGCT), Static induction transistor (SIT), Emitter Switched Thyristor. Silicon Carbide, Power Integrated Circuits, New Semiconductor Materials for Power Devices.

REFERENCE BOOKS:

1. Ned Mohan, Tore M. Undeland, William P. Robbins, **"Power Electronics Converters, Applications, and Design",** 3rd Edition. Wiley India Pvt Ltd, 2011.
2. M.H. Rashid**, Power Electronics: Circuits, Devices, and Applications,** Published by Prentice Hall, 3rd Edition, 2004.
3. G. Massobrio, P. Antognetti, **"Semiconductor Device Modeling with Spice",** McGraw-Hill, 2nd Edition, 2010.
4. B. Jayant Baliga, "**Power Semiconductor Devices**", PWS Publication, 1st Edition, 1995.
5. Benda, J. Gowar, and D. A. Grant, "**Discrete and Integrated Power Semiconductor Devices: Theory and Applications**", John Wiley &Sons, 1999.
6. NPTEL: Electrical Engineering **-** Power Electronics – for Power Semiconductor Devices nptel.ac.in/downloads/108105066/

Subject	SOLID STATE POWER CONTROLLERS	Sub-code	18EEPEPCSP
Credits	**04**	**L-T-P**	**3-0-1**

Course outcomes:
CO1: Analyze the performance of single phase and three phase AC- DC converters in all the modes of operation.
CO2: Analyze the performance of single phase and three phase inverters and evaluate.
CO3: Analyze and evaluate different PWM schemes for voltage control and harmonic reduction in inverters.
CO4: Conduct performance analysis of different choppers.
CO5: Conduct experiment / simulation studies on single phase and three phase power electronic converters and write a report.

Unit 1: 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, twelve pulse converter and design of converter circuits.

Unit 2: Inverters: Principle of operation, performance parameters, single phase bridge inverters and three phase inverters.

Unit 3: 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 4: Multilevel Inverters: Introduction, types, diode clamped, flying capacitor, cascaded multilevel inverters, features & applications.

Unit 5: DC-DC Converters: Principle of operation, analysis of step-down and step-up converters, classification of chopper & chopper circuit design.

Lab experiments:
Experimental and simulation studies on
- Converters
- Inverters and
- Choppers

REFERENCE BOOKS:

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

Subject	MODELING AND SIMULATION OF POWER ELECTRONIC SYSTEMS	Sub-code	18EEPEPCMS
Credits	04	L-T-P	3-0-1

Course outcomes:
CO1: Apply mathematical skills and modelling methods to represent a physical system.
CO2: Design and develop digital controllers to control Power Electronics systems parameters.
CO3: Develop various Power Electronics circuits using modern engineering software tools and prepare a technical report.
CO4: Analyze performance of various Power Electronics circuits.

Unit 1: 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 zeroes circuit averaging method of modelling approach for switched power electronic circuits, space vector modeling, space vectors, 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.

Unit 2: Control System Essentials: Representation of system in digital domain, Z transform, Mapping between s- plane and Z- plane, Continuous to Discrete domain conversion, Hold equivalence

Unit 3: Digital Controller Design: Controller design techniques, Bode diagram method, PID controller, design, root locus method, state space method. Tracker, controller design, controlling voltage, controlling current.

Unit 4: 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.

Unit 5: Implementation examples: PI controller, sine and cosine, pulse width modulation, space vector PWM, over-modulation.

Lab experiments:
- Modeling using state space representation, transfer function representation of a system.
- Modeling of an armature controlled DC motor
- Modeling of a Buck converter
- Three phase to two phase transformations
- Modeling of three phase Induction motors
- Controllers design techniques – Bode and root locus method
- PID controllers for voltage and current control

REFERENCE BOOKS:
1. Ned Mohan, Tore M. Undeland, William P. Robbins, “Power Electronics Converters, Applications, and design”, 3rd Edition, John Wiley & Sons, 2009.
2. L.Umanand,"Power Electronics Essentials and Applications", 1st Edition, John Wiley & Sons, 2009.

ELECTIVE - I

Subject	DIGITAL MEASUREMENTS	Sub-code	18EEPEPEDM
Credits	03	L-T-P	3-0-0

Course outcomes:
CO1: Realize the significance of digital based measurements using Microprocessor/Microcontroller.
CO2: Analyze time and frequency measurement techniques and apply the knowledge for the design of various circuits.
CO3: Realize and design different D/A converters.
CO4: Design A/D converters and apply the concept of voltage measurement technique for various systems.

Unit 1: Philosophy of digital and microprocessor/microcontroller based instruments.

Unit 2: Time measurement techniques: measurement of time interval between events, Order of events, Vernier technique, very low time, period, phase time constant, Capacitance measurements, decibel meter.

Unit 3: Frequency measurement techniques: frequency ratio and product, high and low frequency measurements, deviation meter, tachometer, peak/valley recorder.

Unit 4: DACs: programmable amplifier as DACs, multistage WRDACs, weighted current, weighted reference voltage, weighted charge, DACs, ladder DACs, design of DACs with respect to spread and total resistance, hybrid multiplier and divider Circuits

Unit 5: Voltage measurement techniques: V/f and V/f converters, direct type ADC ramp, tracking, dual slope, successive approximation and flash type multistage flash type ADCs, DVM and its design .

REFERENCE BOOKS:

1. Rathore, T.S., “Digital Measurement Techniques”, Narosa Publishing House, 2003
2. Sonde., B.S., “Monographs on System Design Using Integrated Circuits”, Tata McGraw Hill, 1974
3. Defatta, D.J., Lucas, J.G., Hodgkiss, W.S., “Digital Signal Processing”, John Wiley and Sons, 1988.

Subject	MODELING AND ANALYSIS OF ELECTRICAL MACHINES	Sub-code	18EEPEPEMA
Credits	03	L-T-P	3-0-0

Course outcomes:
CO1: Apply basic concepts of modeling for DC Machines, three phase induction machine and synchronous machines.
CO2: Model a single phase & three phase transformers, autotransformers and transmission line**.**
CO3: Carry out the dynamic performance analysis of synchronous machines.

Unit 1: 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 zeroes circuit averaging method of modelling approach for switched power electronic circuits, space vector modeling, space vectors, 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.

Unit 2: Control System Essentials: Representation of system in digital domain, Z transform, Mapping between s- plane and Z- plane, Continuous to Discrete domain conversion, Hold equivalence

Unit 3: Digital Controller Design: Controller design techniques, Bode diagram method, PID controller, design, root locus method, state space method. Tracker, controller design, controlling voltage, controlling current.

Unit 4: 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.

Unit 5: Implementation examples for PI controller, sine and cosine, pulse width modulation, space vector PWM, over-modulation.

Lab experiments:

- Modeling using state space representation, transfer function representation of a system.
- Modeling of an armature controlled DC motor
- Modeling of a Buck converter
- Three phase to two phase transformations
- Modeling of three phase Induction motors
- Controllers design techniques – Bode and root locus method
- PID controllers for voltage and current control

REFERENCE BOOKS:
1. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and design", 3rd Edition, John Wiley & Sons, 2009.
2. L.Umanand,"Power Electronics Essentials and Applications", 1st Edition, John Wiley & Sons, 2009.

Subject	POWER ELCTRONICS IN SMART GRID	Sub-code	18EEPEPEPS
Credits	03	L-T-P	3-0-0

Course outcomes:
CO1: Acquire in-depth knowledge of Smart Grid, distributed generation, Electro Magnetic Compatibility (EMC) in power system, high frequency AC power distribution platforms and analyze power quality problems in an electricity network.
CO2: Apply the concept of distributed generation and solve the problem of its integration with the existing power system network.
CO3: Learn and explain in the form of presentation and report about different active power controllers used in different places of power system network.
CO4: Analyse the importance of different energy storage systems in the smart grid concept of complex power system.

Unit 1: Introduction: Introduction to smart grid, electricity network, local energy networks, electric transportation, low carbon central generation, fundamental problems of electrical power systems, attributes of the smart grid, alternate views of a smart grid. Power quality and EMC, power quality issues, monitoring, legal and organizational regulations, mitigation methods, and EMC related phenomena in smart system.

Unit 2: High frequency AC Power Distribution Platforms: High frequency in space application, high frequency in telecommunications, high frequency in automotive and motor drives, high frequency in micro grids, future prospects.

Unit 3: Integration of Distributed Generation with Power System: Distributed generation past and future, interconnection with a hosting grid, integration and interconnection concerns, distributed generation contribution to power quality problems and current challenges, power injection principle, injection using static compensators and advanced static devices.

Unit 4: Active Power Controllers: Dynamic static synchronous controllers, D – STATCOM, Dynamic static synchronous series controllers, dynamic voltage restorer, AC/AC voltage regulators.

Unit 5: Energy Storage Systems: Introduction, structure of power storage devices, pumped – storage hydroelectricity, compressed air energy storage system, flywheels, battery storage, hydrogen storage, super conducting magnet energy storage, super capacitors, applications of energy storage devices.

REFERRENCE BOOKS:
1. Strzelecki Benysek, “Power Electronics in Smart Electrical Energy Networks”, Springer, 2008.
2. Clark W Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Side Response”, CRC Press, 2009.

ELECTIVE - II

Subject	EMBEDDED SYSTEM DESIGN	Sub-code	18EEPEPEES
Credits	03	L-T-P	3-0-0

Course outcomes:
CO1: Apply the basic concepts and design an embedded system for real time applications.
CO2: Analyze different techniques to provide solutions for practical problems.
CO3: Evaluate and select a high performance processor to develop a real time system.
CO4: Present and prepare a technical report for a specific real time embedded system.

Unit 1: Introduction to Embedded System: An embedded system, processor, hardware unit, software embedded into a system, example of an embedded system, OS services, real time and embedded OS.

Unit 2: Processor and Memory Organization: Structural unit in a processor, processor selection for an embedded systems, memory devices, memory selection for an embedded system, allocation of memory to program segments and blocks, and direct memory accesses.

Unit 3: Real Time System: Types, real time computing, design issues, ARM system architecture, high performance processors - strong ARM processors, addressing modes, instruction set, and few basic assembly language programs.

Unit 4: Real Time Operating System: Fundamental requirements of RTOS, real time kernel, schedulers, various scheduling modules, latency (interrupt latency, scheduling latency and context switching latency), tasks, state transition diagram, task control block. Inter-task communication and synchronization of tasks.

Unit 5: Building real time applications.

REFERENCE BOOKS:

1. Rajkamal “Embedded System Architecture: Programming & Design”, TMH, 2010.
2. David E. Simon, “An Embedded Software Primer”, Pearson Education, 1999.
3. Philip. A. Laplante, “Real-Time Systems Design and Analysis- An Engineer’s Handbook”- 2nd Edition, Pearson.
4. Jane W.S. Liu, “Real-Time Systems”, Pearson Education Inc, 2012.
5. K.V.K K Prasad, “Embedded Real Time Systems: Concepts Design and Programming”, Dreamtech Press New Delhi, 2003.

Subject	CMOS VLSI DESIGN AND SYSTEM ON CHIP	Sub-code	18EEPEPECV
Credits	**03**	**L-T-P**	**3-0-0**

Course Outcomes:
CO1: Apply the basics of CMOS technology and its characterization and performance Estimation.
CO2: Analyze the design strategies and testing methods for CMOS sub-systems**.**
CO3: Identify various SoC design structures.
CO4: Realize SoC system design models in computation, co design and prepare a technical report.

Unit 1: INTRODUCTION TO CMOS CIRCUITS: MOS Transistors, MOS Transistors switches, CMCS logic circuit and System representations, MOS Transistor theory – Introduction MOS device design equation, the complementary CMOs inverter – DC characteristics, Static Load MOS inverters, the differential inverter, the transmission gate, Tri state inverter.

Unit 2: CIRCUIT CHARACTERISATION AND PERFORMANCE ESTIMATION & CMOS CIRCUIT AND LOGIC DESIGN: Introduction, Resistance estimation, Capacitance estimation, Inductance estimation, Switching characteristics of CMOS gate Transistor, Sizing, Power Dissipation, Sizing Routing conductors, Charge sharing, Design Margining, Reliability. CMOS Logic Gate design, Basic Physical Design of simple gate, CMOS Logic structures clocking strategies, I/O Structures, Low Power Design.

Unit 3: CMOS SYSTEMS DESIGN: Design Strategies CMOS chip Design options, Design Methods, Design Capture Tools, Design Verification Tools, Design Economics, and Data Sheets. CMOS Testing – Manufacturing Test Principles, Design Strategies for Test, Chip level Test Techniques, System Level Test Techniques.

Unit 4: INTRODUCTION to SoC: Introduction to SoC Design., Platform-Based SoC Design., Multiprocessor SoC and Network on Chip, Low-Power SoC Design.

Unit 5: SOC SYSTEM DESIGN: System Models, Validation and Verification, Hardware/Software Co-design Application Analysis.

REFERENCE BOOKS:

1. Nell H E Weste and Kamran Eshraghian, "Principles Of CMOS VLSI Design", 2nd Edition, Addision Westley, 1998.
2. Jaycob Backer, Harry W L and David E Byce, "CMOS Circuit Design, Layout and Simulation", PHI, 1998.
3. Hoi-jun yoo, Kangmin Lee, Jun Kyoung kim, "Low power NoC for high performance SoC desing",CRC press, 2008.
4. Vijay K. Madisetti Chonlameth Arpikanondt, "A Platform-CentricApproach to System-on-Chip (SOC) Design", Springer, 2005.
5.NPTEL Electronics & Communication Engineering - VLSI Design nptel.ac.in/downloads/117101058.
6. CMOS Analog VLSI Design - nptel- nptel.ac.in/courses/117101105/
7. Advanced VLSI Design - nptel- nptel.ac.in/courses/117101004/
8. System On Chip (SOC) - nptel nptel.ac.in/courses/108102045/10

Subject	ADVANCED CONTROL SYSTEM	Sub-code	18EEPEPEAC
Credits	03	L-T-P	3-0-0

Course outcomes:
CO1: Create state models for continuous and discrete time systems.
CO2: Identify appropriate techniques to analyze both continuous and discrete systems for controllability and observability
CO3: Apply relevant concepts to design continuous and discrete systems with state feedback to meet the specifications.

Unit 1: Digital Control Systems: Review of difference equations and Z - transforms, Z- transfer function (Pulse transfer function), Z - Transforms analysis, sampled data systems.

Unit 2: S**tability analysis** (Jury's Stability Test and Bilinear Transformation), pulse transfer functions and different configurations for closed loop discrete-time control systems.

Unit 3: Modern Control Theory: State model for continuous time and discrete time systems, solutions of state equations (for both continuous and discrete systems), 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.

Unit 4: Optimal control problems using state variable approach, state regulator and output regulator, concepts of model reference control systems, adaptive control systems and design.

Unit 5: Non Linear Control Systems: Common nonlinearities, singular points, stability of nonlinear systems - phase plane analysis and describing function analysis, Lyapunov's stability criterion, Popov's criterion.

REFERENCE BOOKS:

1. Ogata. K. "Modern Control Engineering", 5th Edition, PHI, 2010.
2. Ogata K "Discrete Time Control Systems", 2nd Edition, PHI, 2011.
3. Nagarath and Gopal, "Control Systems Engineering", New Age International Publishers, 2012.
4. M Gopal "Modem Control System Theory", New Age International, 2011.
5. M. Gopal, "Digital Control & State Variable Methods", TMH, 2011.

INSTITUTION CORE COURSE

Subject	RESEARCH METHODOLOGY & IPR	Sub-code	18HSMCICRM
Credits	02	L-T-P	2-0-0

Course outcomes:
CO1: Able to write and present a substantial technical report/document
CO2: Able to demonstrate a degree of mastery over the area of specialization

Module 1:
Meaning and sources of research problem, , Objectives and Characteristics of research – Errors in selecting research problem, Research methods Vs Methodology - Types of research-Criteria of good research – Developing a research plan.
Module 2:
Investigations of a research problem - Selecting the problem - Necessity of defining the problem – Data collections-analysis- Importance of literature review in defining a problem - Survey of literature - Necessary instrumentations
Module 3:
How to write paper-conference articles-poster preparation, thesis report writing, inclusion of references, journal reviewing process, journal selection process, filling about journal template, developing effective research proposal-plagiarism-research ethics

Module 4:
Nature of Intellectual property, IPRs- Invention and Creativity - Importance and Protection of Intellectual Property Rights (IPRs) – procedure for grant of patents and patenting under PCT-types of patents-technological research and innovation- international cooperation on IP.
Module 5:
A brief summary of : Patents-Copyrights-Trademarks, patent rights-licensing and transfer of technology-patent databases-case studies on IPR-Geographical indications-new developments in IPR-protection of IPR rights

REFERENCE BOOKS:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2
5. Subbarau NR-Handbook of Intellectual property law and practise- S Viswanathan Printers and Publishing Private Limited 1998.

II SEMESTER

Subject	AC AND DC DRIVES	Sub-code	18EEPEPCAD
Credits	04	L-T-P	3-0-1

Course outcomes:
CO1: Analyze AC-DC Drives circuits critically, in a wider theoretical context.
CO2: Evaluate and choose the appropriate converter topology for different AC-DC drives circuits.
CO3: Develop simulation models for AC-DC drives systems prescribed in the curriculum.
CO4: Apply appropriate techniques, design and tools, to conduct experiments, compare and analyze the hardware results with that of simulation results and prepare a technical report.

Unit 1: Electric Drives: Introduction – block diagram-classification of electrical drives-choice of electrical drives-fundamental torque equation- components of load torque- steady state stability.

Unit 2: DC Drives: Single Quadrant Drive: 1-Phase semi and half wave converter drives, Two quadrant Drive: 1-phase and 3-phase full converter drive.

Unit 3: Two and Four Quadrant drive: 1-phase and three- phase dual converter drive, different braking methods and closed loop control of DC drives.

Unit 4: 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.

Unit 5: Closed Loop Control of AC Drives: Stator voltage control, V/f control, Slip regulation, speed control of static Kramer's drive, current control, brushless DC motor, stepper motor and variable reluctance motor drives.

Lab experiments:
Experimental/Simulation studies on
- Converter fed separately excited DC drives
- Chopper drives
- Speed control of 3 phase Induction motor
- Chopper/Inverter Circuit design using TL 494 CHIP.
- Chopper/Inverter Circuit design using SG 3524 CHIP.

REFERENCE BOOKS:

1. Bose B. K, "Modern Power Electronics & AC Drives" PH I, 2011.
2. Murphy JMD, Turnbull F.G., "Thyristor Control of AC Motors" Pergamon Press Oxford, 1998.
3. R. Krishanan "Electric Motor Drives", EEE, PHI, 2010.
4. M.H Rashid, "Power Electronics, Circuits, Devices & Applications" Third Edition, PHI, New Delhi 2004.
5. High Performance Control of AC Drives "Haitham Abu - Rub, AtifIqbal, Jaroslaw Guzinski, Wiley, 2012.

Subject	SWITCHED MODE POWER CONVERSION	Sub-code	18EEPEPCSM
Credits	**04**	**L-T-P**	**3-0-1**

Course outcomes:

CO1: Analyze the performance of basic converters for CCM and DCM operation.

CO2: Carry out the performance analysis of derived converters and evaluate.

CO3: Analyse the dynamic response of converter using state space averaging and design controller.

CO4: Apply the concept of resonant converters and conduct performance studies of different resonant converters.

CO5: Conduct experiment/simulation studies on basic converters and derived converters for CCM/DCM operation and prepare a technical report.

CO6: Design magnetic components for high frequency SMPS and submit a report.

Unit 1: DC – DC Converters (Non isolated Converters): 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 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).

Unit 2: Isolated 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.

Unit 3: 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, Type-3 error amplifier with compensation, design.

Unit 4: 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.

Unit 5: Introduction on design of Inductors and transformers: Design of inductor for Buck converter and transformer design for Forward converter as case studies.

Lab experiments:

Experimental/Simulation studies on

- Buck converter
- Boost converter
- Buck/Boost converter for CCM & DCM mode
- Flyback and forward converter
- Resonant converter

REFERENCE BOOKS:

1. Daniel W Hart, "Power Electronics", Tata McGraw Hill, 2011.
2. Rashid M.H., "Power Electronics – Circuits, Devicesand Applications", 3rd Edition, Pearson, 2011.
3. D M Mitchel, "DC-DC Switching Regulator Analysis" McGraw-Hill Ltd, 1988.
4. Umanand L and Bhatt S R, "Design of Magnetic Components for Switched Mode Power Converters", New Age International, New Delhi, 2001
5. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition, Wiley India Pvt. Ltd, 2010

Subject	FACTS CONTROLLERS IN POWER TRANSMISSION AND DISTRIBUTION	Sub-code	18EEPEPCFC
Credits	**04**	**L-T-P**	**3-1-0**

Course outcomes:
CO1: Model and analyze the AC transmission lines with and without the FACTS controllers.
CO2: Design controllers for various FACTS controllers.
CO3: Analyze the performance of FACTS controllers.
CO4: Carry out simulation/activities on FACTS controllers and prepare technical reports.

Unit 1:Introduction: Basics of power transmission networks - control of power flow in AC - transmission line- flexible ACtransmission system controllers – application of FACTS controllers in distribution systems. Analysis of uncompensated AC Line - passivereactive power compensation - compensation by a series capacitor connected at the midpoint of the line - shunt compensation connected at the midpoint of the line - comparison between series and shunt capacitor.

Unit 2 :Static Var Compensator: Analysis of SVC - Configuration of SVC- SVC Controller – voltage regulator design -some issues - harmonics and filtering– modeling of SVC – applications of SVC.

Thyristor 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 - applications of TCSC.

Unit 3:Static Synchronous Compensator (STATCOM): Introduction - principle of operation of STATCOM - a simplifiedanalysis 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.

Unit 4: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.

Unified Power Flow Controller (UPFC) – Introduction, Operation of a UPFC, Control of series and shunt converters.

Unit 5: Custom Power Devices: Introduction, Active filters.

Load Compensation and DSTATCOM: Introduction, Compensation using DSTATCOM for a three phase three wire system, Expression for current and power components using Phase coordinates.

REFERENCE BOOKS:

1. K.R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International, 2007.
2. Narain G Hingorani and L. Gyugyi, "Understanding FA CTS: Concepts and Technology of Flexible AC Transmission Systems", Wiley India, 2011.

ELECTIVE – III

Subject	POWER ELECTRONICS SYSTEM DESIGN USING ICs	Sub-code	18EEPEPEPD
Credits	03	L-T-P	3-0-0

Course outcomes:
CO1: Analyze power electronic systems using ICs.
CO2: Design high performance power electronic circuits using different ICs for various applications.
CO3: Design a Power Electronic System using Microcomputer and DSP Control.
CO4: Analyze the performance of a Power Plant using Programmable Logic Controller.
CO5: Think laterally and originally to solve power electronic circuits, and evaluate problems for Practical switching power supplies and prepare a report.

Unit 1: Switching Regulator Control Circuits: Introduction, isolation techniques of switching regulator systems, PWM systems.

Unit 2: 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, current limit circuits, over voltage protection, AC line loss detection, Implementation of different gating circuits.

Unit 3: Microcontroller and Digital ICs for control of Power Electronic Systems: Microcomputer control of Power Electronic Systems, Digital vs Analog control, Real time control using Microcomputer, Advanced Microprocessor and DSP based control of P. E Systems, ASICs for control, Digital control using FPGA & PLDs, Design of Microprocessor based Control Systems, Application examples.

Unit 4: 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 1852 resonant mode power supply controller.

Unit 5: Programmable Logic Controllers (PLC): Basic configuration of a PLC, Programming using Ladder diagram for PLC, program modification, power plant control using PLCs.

REFERENCE BOOKS:

1. G. K. Dubey, S. R. Doradla, A. Johsi, and R. M. K. Sinha, “Thyristorised Power Controllers”,
2. 2nd Edition, New Age International, 2010.
3. Chryssis “High Frequency Switching Power Supplies”, 2ndEdition, MGH, 1989.
4. Unitrode application notes: http://www.smps.us/Unitrode.html

Subject	HVDC TRANSMISSION SYSTEMS	Sub-code	18EEPEPEHV
Credits	03	L-T-P	3-0-0

Course outcomes:
CO1: Justify the application of AC or HVDC transmission systems based on the power transmission scenario such as quantum of power to be transferred, economics, reliability factors, etc.
CO2: Model HVDC transmission systems.
CO3: Analyze the HVDC transmission systems.
CO4: Design various controllers and filters for HVDC systems.

Unit 1: 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.

Unit 2: 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 voltage source converters.

Unit 3: Control of Converters and HVDC link: DC link control principles, converter control characteristics, firing angle control, current and extinction angle control, Power control, Reactive power control, Control of voltage source converter.

Unit 4: 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.

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

Unit 5: Reactive Power Control: Reactive power control in steady state and transient state, sources of reactive power, SVC and STATCOM.
Harmonics and Filters: Introduction, Generation of harmonics, design of AC and DC filters
Multi Terminal DC Systems: Introduction, applications, types.

REFERENCE 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.
4. S Kamakshaiah and V Kamaraju, “HVDC Transmission”, TMH, 2011.
5. Vijay K Sood, “HVDC and FACTs Controllers; Applications of Static Converters in Power Systems”, BSP Books Pvt. Ltd, First Indian reprint 2013.

Subject	PWM CONVERTERS AND APPLICATIONS	Sub-code	18EEPEPEPW
Credits	03	L-T-P	3-0-0

Course outcomes:
CO1: Develop and analyze various PWM Techniques for converters.
CO2: Analyze & estimate the various losses in converters**.**
CO3: Model the PWM Converters and Induction motor drives**.**
CO4: Apply various compensation techniques for the converters.

Unit 1: AC/DC and DC/AC Power Conversion: Overview of applications of voltage source converters.

Unit 2: PWM Techniques: Pulse modulation techniques for I – phase bridges, bus clamping PWM, space vector based PWM, advanced PWM techniques.

Unit 3: Loss Calculations: Practical devices in converters, calculation of switching and conduction losses, compensation for dead time and DC voltage regulation.

Unit 4: Modeling: Dynamic model of PWM converters; constant V/F induction motor drives; estimation of current ripple and torque ripple in inverter fed drives.

Unit 5: Converters with Compensation: Line-side converters with power factor compensation, reactive power compensation, harmonic current compensation.

REFERENCE BOOKS:

1. Mohan, Undeland and Robbins, “Power Electronics: Converter, Applications and Design”, Wiley India, 2011.
2. Erickson RW, “Fundamentals of Power Electronics”, Chapman Hall, 1997.
3. Joseph Vithyathil, “Power Electronics- Principles and Applications”, TMH, 2011.

ELECTIVE-IV

Subject	POWER QUALITY ENHANCEMENT USING CUSTOM POWER DEVICES	Sub-code	18EEPEPEPC
Credits	03	L-T-P	3-0-0

Course outcomes:
CO1: Analyze the Power quality issues and concerns of the country.
CO2: Identify the type of Power quality problems with reference to IEEE/IET standards.
CO3: Analyze, evaluate and realize the control techniques for power quality problems.
CO4: Decide on choosing the necessary monitoring equipment and mitigation techniques.

Unit 1: Introduction and Characterization of Electric Power Quality: Electric Power Quality, Power Electronic applications in Power Transmission Systems, Power Electronic applications in Power Distribution Systems. Power Quality terms and Definitions, Power Quality Problems.

Analysis and Conventional Mitigation Methods: Analysis of Power Outages, Analysis of Unbalance, Analysis of Distortion, Analysis of Voltage Sag, Analysis of Voltage Flicker, Reduced Duration and Customer impact of Outages, Classical Load Balancing Problem, Harmonic Reduction, Voltage Sag or Dip Reduction.

Unit 2: Custom Power Devices: Introduction, Utility-Customer Interface, Custom Power Devices, Custom Power Park, Status of Application of CP Devices, Closed-Loop Switching Control, Second and higher order Systems.

Unit 3: Solid State Limiting, Breaking and Transferring Devices: Solid State Current Limiter, Solid State Breaker, Issues in Limiting and Switching operations, Solid State Transfer Switch, Sag/Swell Detection Algorithms.

Unit 4: Generation of Reference Parameter : Generating Reference Currents Using Instantaneous PQ Theory, Generating reference currents using instantaneous Symmetrical Components, General Algorithm for generating reference currents, Generating Reference currents when the Source is Unbalanced.

Unit 5: Active Power Filters: Series Active Filter**,** Shunt Active Filter, UPQC Configurations, Right-Shunt UPQC Characteristics, Left-Shunt UPQC Characteristics, Structure and Control of Right-Shunt UPQC, Structure and Control of Left-Shunt UPQC.

REFERRENCE BOOKS:

1. Arindam Ghosh et.al, Power Quality Enhancement Using Custom Power Devices, Kluwer Academic Publishers, 2002.
2. Math H J Bollen, “Understanding Power Quality Problems; Voltage Sags and Interruptions”, Wiley India, 2011.
3. Roger C Dugan, et.al, “Electrical Power Systems Quality”, 3rd Edition, TMH, 2012.
4. G T Heydt, “Electric Power Quality”, Stars in Circle Publications, 1991.
5. Ewald F Fuchs, et. el, “Power Quality in Power System and Electrical Machines”, Academic Press, Elsevier, 2009.
6. C. Shankaran “Power Quality”, CRC Press, 2013.
7. Ewald F Fuchs, et. el, “Power Quality in Power System and Electrical Machines”, Academic Press, Elsevier, 2009.
8. C. Shankaran “Power Quality”, CRC Press, 2013.

Subject	ELECTRO MAGNETIC COMPATIBILITY	Sub-code	18EEPEPEEM
Credits	**03**	**L-T-P**	**3-0-0**

Course outcomes:
CO1: Analyse the fundamentals and reasons for noise in Analog electronics, Power electronics and Digital electronics circuit.
CO2: Design and develop filters for Analog electronics, Power electronics and Digital circuits for reduction of noise.
CO3: Design the various types of grounding systems and get familiarised with handling electro static discharge systems, testing standards and Regulations.
CO4: Acquire knowledge about testing standards and regulations.

Unit 1: Review of EMI Theory: Sources of EMI, noise pick up modes and reduction techniques for analog circuits.

Unit 2: Emissions and Reduction Techniques: Use of co-axial cables and shielding of signal lines, conducted and radiated noise emission in power electronic equipment and reduction techniques.

Unit 3: EMI induced failure mechanisms for power electronic equipment, EMC in design of digital circuits.

Unit 4: Electrostatic Discharge: ESD and switching interference reduction, susceptibility aspects of power electronic and digital equipment.

Unit 5: Shielding of electronic equipment.

REFERENCE BOOKS:

1. Otto H. W., "Noise Reduction Techniques in Electronic Systems", 2nd Edition, John Wiley and Sons, 1988.
2. Paul Clayton, "Introduction to Electromagnetic Compatibility", 2nd Edition, Wiley Inter science, 2006.
3. William B. Greason, "Electrostatic Damage in Electronics: Devices and Systems", John Wiley and Sons, 1 986.
4. Joseph Di Giacomo, "Digital Bus Hand Book", McGraw Hill Publishing Company, 1990.
5. White, R. J., "Handbook Series of Electromagnetic Interference and Compatibility", Don White consultants Inc. 1981.

Subject	ELECTRIC VEHICLES	Sub-code	18EEPEPEEV
Credits	03	L-T-P	3-0-0

Course outcomes:

CO1: Acquire in depth knowledge of the electric vehicle system and its components and various modes of operation.

CO2: Estimate and analyze the performance parameters including energy consumption, tractive effort etc. associated with an electric vehicle under different conditions of operation and also various types of electric drive systems suitable for electric vehicle operation.

CO3: Design a battery operated electric vehicle for a given specification.

CO4: Prepare and present a technical report on modeling and operation of Electric vehicles.

Unit 1: Environmental impact and history of modern transportation: Air pollution, global warming, importance of different transportation, history of electric vehicles.

Unit 2: Fundamentals of vehicle propulsion and break: General description of vehicle movement, Vehicle resistance dynamic equation, tire ground adhesion, and maximum tractive effort. Power train tractive effort and vehicle speed, vehicle power plant and transmission characteristics, vehicle performance, brake performance.

Unit 3: Electric Vehicles and Electric propulsion system: Configuration of EVs, performance of EVs, tractive effort in normal driving, energy conversion. DC motor drives, permanent magnet BLDC motor drives, SRM drives.

Unit 4: Energy storages for electric vehicles: Electrochemical batteries, ultra capacitors, ultra high speed flywheels, hybridization of energy storage.

Unit 5: Fundamentals of regenerative braking: Braking energy consumed in urban driving, Braking energy versus vehicle speed, braking power, vehicle speed, vehicle deceleration rate.

REFERENCE BOOKS:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles; Fundamentals Theory and Design”, Second Edition, CRC Press.
2. Iqbal Husain, “Electric and Hybrid Vehicles; Design Fundamentals”, CRC Press.

INSTITUTION ELECTIVE

Subject	RENEWABLE ENERGY & PHOTOVOLTAICS	Sub-code	18EEPEIERE
Credits	04	L-T-P	4-0-0

Course outcomes:

CO1: Acquire in depth knowledge about different types of renewable & non-renewable sources and the physics of photovoltaic system.

CO2: Apply knowledge of mathematics to solve problems related to solar radiation & measurement, basic sun earth angles, and cell characterization.

CO3: Analyze the concept of MPPT Algorithms, economic aspects of PV systems and design of charge controllers.

CO4: Design and model PV cells & modules for roof top and grid connected systems and analyze the issues related to grid integration, interfacing and power quality.

Unit 1: Introduction: Energy sources and their availability, commercial or conventional energy sources- thermal, hydro and nuclear, new energy technologies, renewable energy sources, prospects of renewable energy sources.

Unit 2: Physics of Photovoltaic Systems: Introduction, doping, Fermi Level, p-n junction, p-n junction characteristics, photo voltaic effect, I-V and P-V characteristics, photovoltaic material, shading effect on module, cell temperature.

Unit 3: Photovoltaic energy conversion: Solar radiation and measurements, solar constant, basic sun earth angles-definitions and their representation, solar cell fabrication.

Unit 4: Solar electric system: Charge controllers, Maximum power point tracking algorithms, Design of roof top solar PV systems, economic analysis of PV systems and solar PV applications. Standalone photo voltaic Systems.

Unit 5: Grid integration of photovoltaics: Different topologies for single phase and three phase grid integration, design of grid integrated solar PV system, inverter types, islanding detection, power quality, future developments.

REFERENCE BOOKS:

1. G.D. Rai, “Non-Conventional Energy Sources”, Khanna publishers.
2. Chenming Hu and R.M. White, “Solar Cells from Basics to Advanced Systems, McGraw Hill Book Co.
3. R.Strzelecki and G. Benysek, Editors “Power Electronics in Smart Electrical Energy Networks”, Springer.
4. G.N. Tiwari,”Solar Energy- Fundamentals, Design, Modelling and Applications” Narosa Publishing House.

Subject	MICRO & SMART SYSTEMS	Sub-code	18EEPEIEMS
Credits	04	L-T-P	4-0-0

Course outcomes:

CO1: Acquire in depth concept of micromachining technologies namely vacuum pump, deposition techniques and lithography and acquire knowledge about integration of microsystem.

CO2: Apply the knowledge of applied physics to know the principle of operations of different sensors & actuators.

CO3: Analyze mode of operation of different characterization techniques like SEM, XRD and TEM and further analyze different electronic circuits to control micro systems.

CO4: Prepare and present a technical report on effects of scaling in different domain in Micro Systems.

Unit 1: Introduction and Scaling effects in microsystems: Review of material science, Microsystem versus MEMS, smart materials, structures and systems, integrated microsystems, applications of smart materials and microsystems. Scaling in the mechanical domain, electrostatic domain, magnetic domain, thermal domain, scaling in diffusion, scaling in fluids, scaling effects in the optical domain, scaling in biochemical phenomena.

Unit 2: Micromachining Technologies: Silicon as a material for micromachining, vacuum pumps, thin film deposition, ion implantation, lithography, etching, silicon micromachining, specialized materials for micro systems, advanced processes for micro fabrication.

Unit 3: Micro Sensors, Actuators, Systems and Smart Materials: Silicon Capacitive Accelerometer, piezoresistive pressure sensor, conductometric gas sensor, electrostatic comb drive, magnetic microrelay, portable blood analyzer.

Unit 4: Characterization techniques: Introduction, film thickness, scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-Ray diffraction (XRD), X-ray energy dispersive analysis (EDX).

Unit 5: Electronic Circuits and Control for Micro and Smart Systems: Practical signal conditioning circuits for microsystems, circuits for conditioning sensed signals, introduction to control theory, implementation of controllers. Integration of microsystems and microelectronics, microsystems packaging, case studies of integrated microsystems.

REFERENCE BOOKS:

1. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre, “Micro and Smart Systems”, Wiley- India.
2. Milton Ohring, “Materials Science of Thin Films” 2nd Edition, ELSEVIER, 2012.
3. MEMS Lecture Series (CDS) by Shanthiram Kal.

III SEMESTER

Subject	PROJECT WORK 1(I- PHASE)	Sub-code	18EEPEPCP1
Credits	8	L-T-P	0-0-8

Course outcomes:
CO1: Carry out literature survey from reputed journal/conference publications, and formulate a complex engineering problem.
CO2: Apply the fundamental knowledge of mathematics, engineering and Power Electronics principles in design of solutions or system components.
CO3: Identify, Select, and apply a suitable engineering/IT tool in modeling/data interpretation /analytical studies, conduct experiments leading to a logical solution.
CO4: Design a system/system component, simulate and test its functioning as a solution to a complex engineering problem.
CO5: Prepare a technical report and present the work carried out before the expert committee.
CO6: Communicate effectively the results of publication in a reputed journal/conference.

Subject	INTERNSHIP	Sub-code	18EEPEPCIN
Credits	10	L-T-P	0-0-10

Course outcomes:
CO1: Get an insight into the company profile and understand the organizational structure.
CO2: Apply and correlate theory and practice.
CO3: Communicate effectively regarding complex Engineering activities.
CO4: Demonstrate knowledge and understanding of Engineering & Management principles of the company.
CO5: Engage in life-long learning with a commitment to improve knowledge and competence continuously.
CO6: Acquire professional & intellectual integrity and its impact on the society.
CO7: Prepare and present a technical report for the Internship carried out.

ELECTIVE - V

Subject	INDUSTRIAL SAFETY	Sub-code	18EEPEPEIS
Credits	04	L-T-P	4-0-0

Unit 1: Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Unit 2: Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit 3: Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Unit 4: Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Unit 5: Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

REFERENCE BOOKS:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Subject	COST MANAGEMENT OF ENGINEERING PROJECTS	Sub-code	18EEPEPECE
Credits	**04**	**L-T-P**	**4-0-0**

Unit 1: Introduction and Overview: Strategic Cost Management Process Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making. Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities.

Unit 2: Detailed Engineering activities: Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process, Cost Behaviour and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems.

Unit 3: Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.

Unit 4: Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Unit 5: Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

REFERENCE BOOKS:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Subject	DSP APPLICATIONS TO DRIVES	Sub-code	18EEPEPEDS
Credits	04	L-T-P	4-0-0

Course outcomes:
CO1: Identify the functionality of TMS320LF2407 DSP Controller.
CO2: Analyze various DSP based DC-DC Converters**.**
CO3: Design and develop DSP based control for various motors.

Unit 1: Introduction: To the TMS320LF2407 DSP Controller, C2xx DSP CPU architecture and instruction set.

Unit 2: General Purpose Input/output (GPIO) functionality interrupts on the TMS320LF2407, Analog-to-Digital Converter (ADC), event managers (EVA, EVB).

Unit 3: DSP-Based Applications: Of DC-DC buck-boost converters, DSP based control of stepper motors.

Unit 4: DSP-Based control of permanent magnet brushless DC machines, Park and Clarke's transformations. Space Vector Pulse Width Modulation, DSP-based control of permanent magnet synchronous machines.

Unit 5: DSP-based vector control of induction motors.

REFERENCE 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.

IV SEMESTER

Subject	PROJECT WORK (FINAL PHASE)	Sub-code	18EEPEPCP2
Credits	20	L-T-P	0-0-20

Course outcomes:
CO1: Apply the fundamental knowledge of mathematics, engineering and Power Electronics principles in design of solutions or system components.
CO2: Identify, Select, and apply a suitable engineering/IT tool in modeling/data interpretation/analytical studies, conduct experiments leading to a logical solution.
CO3: Design a system/system component, simulate and test its functioning as a solution to a complex engineering problem.
CO4: Develop a prototype model for the simulated work.
CO5: Communicate effectively the work carried out before the expert committee.
CO6: Develop good technical report.
CO7: Publish the results in a reputed International IEEE conference/journal.

Subject	TECHNICAL SEMINAR	Sub-code	18EEPEPCIN
Credits	02	L-T-P	0-0-2

Course outcomes:
CO1: Carry out literature survey and choose a relevant topic reported in recent IEEE conference publications / IEEE transactions in the domain of Power Electronics
CO2: Simulate and analyze the results reported in the selected paper.
CO3: Communicate effectively before the expert panel and develop Technical reports.
CO4: Respond to the Queries raised by the Evaluation Committee and audience.