KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 060
(Autonomous)

VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

QUALITY POLICY

We are committed to

- Provide value based quality education for developing the student as a competent and responsible citizen.
- Contribute to the nation and beyond through the state of-the-art technology.
- Continuously improve our services.

DEPARTMENT OF EEE

VISION

To be a centre of excellence for development and dissemination of knowledge in Electrical and Electronics Engineering to benefit the society in the National and global level.

MISSION

Department of Electrical and Electronics Engineering is committed to:

MS1: Develop innovative, competent, ethical and quality engineers to contribute for technical advancements to meet societal needs.

MS2: Provide state-of-the-art facilities for continual improvement in teaching-learning process and research activities.

MS3: Enrich the knowledge and skill of the students to cater to the industrial needs and motivate them to become entrepreneurs.

2018 REGULATIONS

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Post Graduates of **Power Electronics and Drives** will

PEO1: Utilize fundamental knowledge of power electronics and drives to succeed in professional and research career.

PEO2: Design, simulate, analyze and develop power electronic and electrical drive based products which are reliable, cost effective and safe.

PEO3: Apply the power electronic applications to electrical system and thereby improve the performance parameters using conventional and advanced control techniques.

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

MS\PEO	PEO1	PEO2	PEO3
MS1	2	3	3
MS2	2	3	3
MS3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

PROGRAM OUTCOMES (POs)	
Post Graduates of Power Electronics and Drives will have	
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	An ability to demonstrate a degree of mastery over the area of Power Electronics and Drives.

MAPPING OF PEOs WITH POs

PEO\PO	PO1	PO2	PO3
PEO1	3	2	3
PEO2	3	2	3
PEO3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

CURRICULUM BREAKDOWN STRUCTURE UNDER REGULATION 2018

Curriculum Breakdown Structure(CBS)	Curriculum Content (% of total number of credits of the program)	Total number of contact hours	Total number of credits
Program Core(PC)	41.66	510	30
Program Electives(PE)	25.00	270	18
Humanities and Social Sciences and Management Studies(HSMS)	5.55	60	4
Project(s)/Internships(PR)/Others	27.77	600	20
Total			**72**

KEC R2018: SCHEDULING OF COURSES – ME (POWER ELECTRONICS AND DRIVES)

Semester	Theory/ Theory cum Practical / Practical						Internship & Projects	Special Courses	Credits
	1	2	3	4	5	6	7	8	
I	18AMT14 - Advanced Mathematics for Electrical Engineers (HS-3-1-0-4)	18PET11 - System Theory (PC-3-1-0-4)	18PET12 - Modeling and Analysis of Electrical Machines (PC-3-1-0-4)	18PEC11- A.C. Converters (PC-3-0-2-4)	18PEC12 - Power Semiconductor Devices and D.C. Converters (PC-3-0-2-4)	18AET13 - Computational Intelligence Techniques (PC-3-0-0-3)	-	-	23
II	18PEC21 - Solid State DC Drives (PC-3-0-2-4)	18PEC22 - Solid State AC Drives (PC-3-0-2-4)	18PET21- Power Electronics for Renewable Energy Systems (PC-3-0-0-3)	Elective-I (Professional) (PE-3-0-0-3)	Elective-II (Professional) (PE-3-0-0-3)	Elective-III (Professional) (PE-3-0-0-3)	18PEP21- Mini Project (PR-0-0-4-2)	-	22
III	Elective-IV (Professional) (PE-3-0-0-3)	Elective-V (Professional) (PE-3-0-0-3)	Elective-VI (Professional) (PE-3-0-0-3)	-	-	-	18PEP31- Project work - Phase I (PR-0-0-12-6)	-	15
IV	-	-	-	-	-	-	18PEP41- Project work - Phase II (PR-0-0-24-12)	-	12

Total Credits: 72

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M.E. DEGREE IN POWER ELECTRONICS AND DRIVES

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
18AMT14	Advanced Mathematics for Electrical Engineers	3	1	0	4	50	50	100	HS
18PET11	System Theory	3	1	0	4	50	50	100	PC
18PET12	Modeling and Analysis of Electrical Machines	3	1	0	4	50	50	100	PC
18PEC11	A.C. Converters	3	0	2	4	50	50	100	PC
18PEC12	Power Semiconductor Devices and D.C. Converters	3	0	2	4	50	50	100	PC
18AET13	Computational Intelligence Techniques	3	0	0	3	50	50	100	PC
	Total				**23**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.E. DEGREE IN POWER ELECTRONICS AND DRIVES

CURRICULUM
(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
18PEC21	Solid State DC Drives	3	0	2	4	50	50	100	PC
18PEC22	Solid State AC Drives	3	0	2	4	50	50	100	PC
18PET21	Power Electronics for Renewable Energy Systems	3	0	0	3	50	50	100	PC
	Elective - I	3	0	0	3	50	50	100	PE
	Elective - II	3	0	0	3	50	50	100	PE
	Elective - III	3	0	0	3	50	50	100	PE
	Practical								
18PEP21	Mini Project	0	0	4	2	100	0	100	PR
	Total				**22**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.E. DEGREE IN POWER ELECTRONICS AND DRIVES

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
	Elective - IV	3	0	0	3	50	50	100	PE
	Elective - V	3	0	0	3	50	50	100	PE
	Elective - VI	3	0	0	3	50	50	100	PE
	Practical								
18PEP31	Project Work Phase I	0	0	12	6	50	50	100	PR
	Total				**15**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

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M.E. DEGREE IN POWER ELECTRONICS AND DRIVES

CURRICULUM

(For the candidates admitted from academic year 2018-19 onwards)

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Practical								
18PEP41	Project Work Phase II	0	0	24	12	50	50	100	PR
	Total				**12**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure

Total Credits: 72

LIST OF PROFESSIONAL ELECTIVES						
Course Code	**Course Title**	**Hours/Week**			**Credit**	**CBS**
		L	**T**	**P**		
SEMESTER II						
18COE04	Electromagnetic Interference and Compatibility	3	0	0	3	PE
18AEE01	Data Communication Networks	3	0	0	3	PE
18AEE03	Programmable Logic Controllers	3	0	0	3	PE
18AEE06	Programmable Digital Signal Processors	2	0	2	3	PE
18PEE01	PWM Techniques and its Applications	3	0	0	3	PE
18PEE02	Optimal Control Theory	3	1	0	4	PE
18PEE03	Switched Mode Power Converters	3	0	0	3	PE
18PEE04	Computer Aided Design of Electrical Machines	3	1	0	4	PE
18PEE05	Microcontroller Applications in Power Electronics	3	0	0	3	PE
18PEE06	Power Quality Engineering	3	0	0	3	PE
18PEE07	Smart Grid	3	0	0	3	PE
18PEE08	Special Electrical Machines and Control	3	0	0	3	PE
SEMESTER III						
18MTE13	MEMS Design	3	0	0	3	PE
18CIE15	Virtual Instrumentation for Industrial Applications	3	0	0	3	PE
18AEE07	Energy Conservation, Management and Auditing	3	0	0	3	PE
18AEE08	Project Management	3	0	0	3	PE
18AEE10	SCADA and DCS	3	0	0	3	PE
18PEE09	Modern Power System Protection	3	0	0	3	PE
18PEE10	Computer Aided Simulation and Design of Power Electronic Systems	3	0	0	3	PE
18PEE11	Embedded System and Applications	3	0	0	3	PE
18PEE12	Hybrid Electric Vehicle Systems	3	0	0	3	PE
18PEE13	Energy Storage Systems	3	0	0	3	PE
18PEE14	Power Electronic Applications in Power Systems	3	0	0	3	PE
18PEE15	Industrial Drives	3	0	0	3	PE

18AMT14 ADVANCED MATHEMATICS FOR ELECTRICAL ENGINEERS

(Common to Applied Electronics & Power Electronics and Drives Branches)

L	T	P	Credit
3	1	0	4

Preamble	This course will help the students to identify, formulate and solve problems in electrical engineering using mathematical tools from a variety of mathematical areas, including matrix theory, calculus of variations, queuing theory and linear programming
Prerequisites	Calculus and Probability

UNIT – I **9**

Advanced Matrix Theory: Matrix factorizations – LU decomposition – The Cholesky decomposition – QR factorization – Least squares method – Generalized inverses – Singular value decomposition – Toeplitz matrices and Circulant matrices.

UNIT – II **9**

Calculus of Variations: Concept of variation – Euler equation – Variational problems with fixed boundaries – Variational problems involving several unknown functions – Functional involving first and second order derivatives – Functional involving several independent variables – Isoperimetric problems – Direct methods – Ritz method – Kantorowich method.

UNIT – III **9**

Stochastic Process: Definition – Classification of Stochastic Processes – Markov Chain -Transition Probability Matrices – Chapman Kolmogorov Equations - Classification of States – Continuous Time Markov Chains – Poisson Process - Birth and Death Processes.

UNIT – IV **9**

Queuing Models: Markovian queues – Single and Multi-server Models – Little's formula – Machine Interference Model - Non- Markovian Queues – Pollaczek Khintchine Formula.

UNIT – V **9**

Linear Programming: Formulation – Graphical solution – Simplex method – Big M method - Two phase method –Transportation and Assignment Problems.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. Richard Bronson, “Matrix Operations”, 2nd Edition, Schaum's Outline Series, McGraw Hill, 2011.
2. Gupta A.S., “Calculus of Variations with Applications”, 12th Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2015.
3. Roy D. Yates and David J. Goodman, “Probability and Stochastic Processes – A friendly Introduction for Electrical and Computer Engineers”, John Wiley & Sons, 2005.
4. Taha H.A., “Operations Research: An Introduction”, 10th Edition, Pearson Education, New Delhi, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply matrix computations in signal processing	Applying (K3)
CO2:	solve variational problems that occur in electrical engineering discipline	Evaluating (K5)
CO3:	use discrete time Markov chains to model computer systems	Applying (K3)
CO4:	exposing the basic characteristic features of a queuing system and acquire skills in analyzing queuing models	Applying (K3)
CO5:	develop a fundamental understanding of linear programming models	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2		
CO2	2		
CO3	1		
CO4	1		
CO5	2		

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PET11 SYSTEM THEORY

(Common to Power Electronics and Drives & Applied Electronics Branches)

L	T	P	Credit
3	1	0	4

Preamble	The aim of the subject is to give an adequate exposure to Z-Plane, State Space, Stability analysis and State Feedback Control
Prerequisites	Control Systems

UNIT – I **9**

Introduction to Digital Control System: Elements of Digital control system - Classifications of discrete time signals - Time domain models for discrete time systems. Sampling and reconstruction of signals - Frequency domain representation of sampling theorem - Nyquist rate, Aliasing. Mathematical model of sample and hold circuits-Practical aspects of choice of sampling rate.

UNIT – II **9**

Z-Plane Analysis of Discrete-Time Control Systems: Review of Z transform - Relationship between s plane and z plane - Difference equation representation of discrete time system - Pulse transfer function - Modified Z transform - Digital PID controllers - Zeigler - Nichols tuning method.

UNIT – III **9**

State Space Analysis and its Solution: Review of state space representation - Conversion of continuous state model to discrete state model - State diagram - Solution of discrete time state model: autonomous, non-autonomous systems - State transition matrix - Controllability and Observability - Multi variable discrete systems.

UNIT – IV **9**

State Feedback Control: Design of state feedback controller - Design of reduced and full order observers - Steady state error in state space - PI feedback - Digital compensator design - Digital filter properties - Kalman‟s filter.

UNIT – V **9**

Stability Analysis: BIBO stability - Effect of sampling rate on stability - Jury's stability test - Root Locus analysis - Asymptotic stability - Liapunov Stability Analysis of discrete time systems: Linear and Non-linear systems - Direct, Indirect method - Construction of Liapunov energy function.

Lecture: 45, Tutorial: 15, Total: 60

REFERENCES:

1. Gopal M., "Digital Control and State Variable Methods", 4th Edition, Tata McGraw Hill, New Delhi, 2012.
2. Kuo B.C., "Digital Control Systems", 2nd Edition, Oxford University Press, 2012.
3. Ogata K., "Discrete Time Control Systems", 2nd Edition, Prentice Hall, New Jersey, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the basic concepts in digital control system	Understanding (K2)
CO2:	analyze the discrete time control system by using Z-plane	Applying (K3)
CO3:	develop the mathematical model of linear discrete-time control systems using transfer functions and state-space models	Understanding (K2)
CO4:	analyze transient and steady-state behaviors of linear discrete-time control systems	Applying (K3)
CO5:	design controllers for linear discrete-time control systems as per the design criteria	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		2
CO2	2		3
CO3	2		2
CO4	2		3
CO5	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PET12 MODELING AND ANALYSIS OF ELECTRICAL MACHINES

L	T	P	Credit
3	1	0	4

Preamble	The objective of the course is to derive, model and analyze the various DC, AC and permanent magnet electrical machines.
Prerequisites	Electrical Machines

UNIT – I **9**

Generalized Machine Theory: Essential of Rotating Electrical Machines – Conventions – The Basic Two Pole Machine – Invariance of Power – MMF Distribution of DC and AC Machines – Transformations from Three Phase to Two Phase – Kron's Primitive Machine – Electrical Torque – Restriction of the Generalized Theory of Electrical Machines – Applications.

UNIT – II **9**

Modeling of DC Machines: Theory of Operation – Induced EMF – Equivalent Circuit – Electromagnetic Torque – Field Excitation- Steady State and Transient Analysis of DC Machine – Separately Excited Motor – Shunt Motor – Series Motor – Compound Motor.

UNIT – III **9**

Modeling of Induction Machines: Three Phase Induction Motor – Voltage and Torque Equation in Machine Variables – Reference Frame Theory – Voltage and Torque Equation in Arbitrary Reference Frame – Voltage and Torque Equation in Stator Reference Frame.

UNIT – IV **9**

Modeling of Synchronous Machines: Three Phase Synchronous Motor – Voltage and Torque Equations in Machine Variables – Voltage Equation in Arbitrary Reference Frame – Voltage Equation in Rotor Reference Frame.

UNIT – V **9**

Modeling of PM Machines: Permanent Magnet Synchronous Motor (PMSM) – Permanent Magnet DC Motor – Magnet and Characteristics – PMSM Voltage and Torque Equation in Machine Variables – Modeling and Analysis of Permanent Magnet DC Motor using MATLAB Simulink.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. Bimbhra P.S., "Generalized Theory of Electrical Machines", 5th Edition, Khanna Publishers, 2014.
2. Paul C. Krause, "Analysis of Electric Machinery", 3rd Edition, McGraw Hill Book Company, 2013.
3. Charles Kingsley Jr., Fitzgerald A.E., and Stephen D.Umans, "Electric Machinery", McGraw-Hill Higher Education, New York, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the importance of mathematical modeling and its application	Understanding (K2)
CO2:	derive the mathematical equation for DC shunt, series and compound motors	Applying (K3)
CO3:	derive the mathematical equation for induction, synchronous and permanent magnet motors	Applying (K3)
CO4:	select and apply various reference frame theories for conventional and special electrical machines	Applying (K3)
CO5:	analyze DC machines and permanent magnet machines	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		2
CO2	3		2
CO3	3		2
CO4	3	1	2
CO5	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEC11 A.C. CONVERTERS

L	T	P	Credit
3	0	2	4

Preamble	The aim of the subject is to understand the working operation of various ac converters and its signification
Prerequisites	Electron Devices , Power Electronics

UNIT – I **9**

Single Phase Inverters: Principle of operation of half and full bridge inverters - Performance parameters- Voltage control of single phase inverters using various PWM techniques - various harmonic elimination techniques.

UNIT – II **9**

Three Phase Inverters: 180^o and 120^o conduction mode of inverters with star and delta connected loads - Voltage control of three phase inverters - Current source inverters - Operation of six-step thyristor inverter - inverter operation modes - load commutated inverters - ASCI- current pulsations - Comparison of CSI and VSI

UNIT – III **9**

AC Voltage Controllers: Principle of On off control and phase control – single phase bidirectional controllers with resistive and inductive loads – Three phase bidirectional delta connected controllers - different Configurations- Analysis with pure R and L loads- Cycloconverters- Principle of operation - single phase and three phase cyclo converters- Control circuit strategies.

UNIT – IV **9**

Resonant Inverters: Resonant inverters -Series and Parallel resonant inverters - Voltage control of resonant inverters – Class E resonant inverter – resonant DC-link inverters - Introduction to matrix converter.

UNIT – V **9**

Multilevel Inverters: Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters –Switching techniques for multilevel inverters - Comparison of multilevel inverters – applications of multilevel inverters – Design and analysis of multilevel inverters for renewable energy applications.

List of Experiments :

1. Design of Voltage Source Inverter using SCR
2. Design of AC to AC converter using SCR
3. Design of single phase cyclo converters
4. Simulation of Three Phase Full Bridge Inverter using PSIM
5. Simulation of Three Phase AC Voltage Controller using PSPICE

Lecture:45, Practical:30, Total: 75

REFERENCES:

1. Rashid M.H., “Power Electronics Circuits, Devices and Applications”, 3rd Edition, Pearson, New Delhi, 2003.
2. Bimal K. Bose, “Modern Power Electronics and AC Drives”, 2nd Edition, Prentice Hall India, 2005.
3. Ned Mohan,Undeland and Robbin, “Power Electronics: Converters, Application and Design”, 3rd Edition, Wiley, Newyork, 2012.
4. Bimbra P.S., “Power Electronics”, 5th Edition, Khanna Publishers, 2012.
5. Sen P.C., “Modern Power Electronics”, 2nd Edition, S.Chand, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	select suitable control techniques for single phase inverter	Understanding (K2)
CO2:	interpret various control methods in three phase inverter	Understanding (K2)
CO3:	examine the operation of various control methods	Applying (K3)
CO4:	explain the concepts of resonant and soft switching converters	Applying (K3)
CO5:	analyze and design multilevel inverters for Renewable Energy sources	Analyzing (K4)
CO6:	design and select suitable converters for specific applications	Applying (K3), Manipulation (S2)
CO7:	design and model the performance characteristics of cycloconverter for variable frequency applications	Applying (K3), Precision (S3)
CO8:	analyze and show the performance of various converters in simulation environments	Analyzing (K4), Precision (S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2		2
CO2	2		2
CO3	3	1	2
CO4	3		2
CO5	3	2	3
CO6	3	2	2
CO7	3	2	2
CO8	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEC12 POWER SEMICONDUCTOR DEVICES AND D.C. CONVERTERS

L	T	P	Credit
3	0	2	4

Preamble	The objective of this course is to study and analyze the characteristics of semiconductor devices. This course also brings an insight to principles of D.C converters.
Prerequisites	Electron Devices, Power Electronics

UNIT – I **9**

Power Semiconductor Characteristics: Steady state, transient characteristics and the parameters of the various devices catalogues: Power diode, SCR, TRIAC, MOSFET, IGBT, GTO, MCT, IGCT and silicon carbide devices – various Protection circuits- Calculation of losses. Thermal resistance and Design of heat sinks for the required loading- Safe Operating Area (SOA) for transistors - Comparison and application of different power devices.

UNIT – II **9**

Single phase AC-DC Converters: Review of half-wave and full-wave diode rectifier-Principle of phase controlled converter operation: Single phase half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes – continuous and discontinuous modes of operation - inverter operation and analysis of single phase semi converter/half controlled converter: Asymmetric and Symmetric configurations-performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap-reactive power and power balance in converter circuits.

UNIT – III **9**

Three Phase AC-DC Converters: Operation of half wave converter-Full wave fully controlled converters: Analysis and operation with different type of loads-Rectification and inversion mode-semi controlled converter-Dual converter: Principal and operation-single phase and three phase configurations-12 pulse converter-Effect of source and load inductances-Applications of AC-DC converters.

UNIT – IV **9**

DC-DC Converters: Basic principle of DC chopper-classification of DC choppers-control strategies-Design and analysis of non-isolated converters: Buck, Boost, Buck-Boost, CUK, SEPIC, Zeta converters with continuous and discontinuous operation.

UNIT – V **9**

Isolated Switch Mode Converters: Design and analysis of isolated switch mode converters- fly back, forward, push-pull, and half bridge, full bridge Converters with continuous and discontinuous operation-Applications of DC-DC converters.

List of Experiments :

1. Design of snubber circuits, semi conductor fuses dv/dt and di/dt protection, gate signal generation and driver circuits.
2. Modeling and simulation of single phase controlled rectifier.
3. Simulation of three phase full converters
4. Design and Simulation of non-isolated switch mode converters
5. Design and Simulation of isolated switch mode converters

Lecture:45, Practical:30, Total: 75

REFERENCES:

1. Mohan N, Undeland and Robins, "Power Electronics – Concepts, Applications and Design", John Wiley & Sons, Singapore, 2012.
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications", 11th Edition, Pearson, 2012.
3. Singh M.D., and Khanchandani K.B., "Power Electronics", 2nd Edition, Tata McGraw Hill, 2006.
4. Sen P.C., "Modern Power Electronics", 2nd Edition, S. Chand, 2005.
5. Bimbra P.S., "Power Electronics", 5th Edition, Khanna Publishers, 2012.
6. Bill Drury, "Control Technique Drives and Controls Handbook", 2nd Edition, IET Power and Energy Series 57.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the characteristics of various power semiconductor devices and protection circuits	Understanding (K2)
CO2:	describe the operation of single phase AC-DC converters and its performance parameters	Understanding (K2)
CO3:	explain the working of three phase AC-DC converters and applications of AC-DC converters	Understanding (K2)
CO4:	analyze and design of non-isolated DC to DC Converters	Analyzing (K4)
CO5:	analyze the types of isolated DC to DC switched mode converters	Analyzing (K4)
CO6:	design and select suitable power semiconductor protective circuits for specific applications	Applying (K3), Manipulation (S2)
CO7:	experiment and document the performance characteristics of power electronic rectifiers for variable DC output applications	Applying (K3), Precision (S3)
CO8:	analyze and show the performance difference of various switched mode converters	Analyzing (K4), Precision (S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		2
CO2	3		2
CO3	3		2
CO4	3	2	2
CO5	3	2	2
CO6	3	2	2
CO7	3	2	2
CO8	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18AET13 COMPUTATIONAL INTELLIGENCE TECHNIQUES

(Common to Applied Electronics & Power Electronics and Drives Branches)

L	T	P	Credit
3	0	0	3

Preamble	This course serves as a guide to explore computer methodology and algorithms that improves automatically through experience.
Prerequisites	Numerical methods

UNIT – I **9**

Artificial Neural Networks: Introduction to Soft computing – Neural Networks – Model – activation functions – architecture – Supervised learning – Perceptrons – Adaline and Madaline – Back propagation algorithm – Radial Basis Function Networks – Unsupervised Learning and Other Neural Networks – Competitive Learning Networks – Kohonen Self Organizing Networks – Learning Vector Quantization – Hebbian Learning.

UNIT – II **9**

Fuzzy Logic: Fuzzy Sets – Basic Definition and Terminology – Set theoretic operations – Membership function formulation and parameterization - Extension principle and Fuzzy Relations- Fuzzy if-then Rules – Fuzzy Reasoning – Fuzzy Inference Systems – Mamdani Fuzzy Models –Sugeno Fuzzy Models –Tsukamoto Fuzzy Models – Input Space Partitioning - Fuzzy Modeling.

UNIT – III **9**

Optimization Techniques: Derivative based Optimization: Descent Methods –The Method of steepest Descent – Classical Newton's Method – Step Size Determination – Derivative free Optimization: Genetic Algorithms – Simulated Annealing – Particle swarm Optimization - Ant colony optimization.

UNIT – IV **9**

Neuro Fuzzy Modeling: Adaptive Neuro Fuzzy Inference Systems – Architecture – Hybrid learning Algorithm –learning methods that Cross-fertilize ANFIS and RBFN – Coactive Neuro fuzzy Modeling – Framework – Neuron Functions for Adaptive Networks – Neuro Fuzzy spectrum.

UNIT – V **9**

Applications: Printed Character Recognition – Inverse kinematics Problem – Applications of soft computing techniques for power electronics: MPPT - Speed control for electrical machines - Harmonic elimination techniques in power converters.

Total: 45

REFERENCES:

1. Jang J.S.R., Sun C.T., and Mizutani E., "Neuro-Fuzzy and Soft Computing", PHI, Pearson Education, 2004.
2. Laurene V. Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms and Applications", 3rd Edition, Pearson Education, 2008.
3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley India.
4. David E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, New York, 1989.
5. Bimal K. Bose, "Neural Network Applications in Power Electronics and Motor Drives-An Introduction and Perspective", IEEE Transactions on Industrial Electronics, Vol.54, Issue: 1, pp.14-33,February 2007.
6. Whei-Min Lin, Chih-Ming Hong and Chiung-Hsing Chen, "Neural Network Based MPPT Control of a Stand Alone Hybrid Power Generation System", IEEE Transactions on Power Electronics, Vol.26, Issue: 12, pp.3571 – 3581, December 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	interpret and analyze various artificial neural networks	Understanding (K2)
CO2:	examine the concepts of fuzzy systems	Analyzing (K4)
CO3:	gain fundamental knowledge on optimization techniques and its implementation procedures	Understanding (K2)
CO4:	illustrate various hybrid topology of neuro fuzzy system	Understanding (K2)
CO5:	develop suitable soft computing technique on real time systems	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	2
CO2	3		2
CO3	3		2
CO4	2	1	3
CO5	3		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEC21 SOLID STATE DC DRIVES

L	T	P	Credit
3	0	2	4

Preamble	The aim of the subject is to understand the conventional and solid state speed control methods pertaining to DC drives.
Prerequisites	Power Electronics, Electrical machines, Electric Drives and Control

UNIT – I **9**

Review of Conventional DC Drives: Basic characteristics of DC motor- starting & braking - Different techniques of speed control of series and separately excited DC motors - Ward-Leonard Speed control of DC motors. Transformer and uncontrolled rectifier control.

UNIT – II **9**

AC-DC Converter Drives: Controlled Rectifier fed DC Drives-Single phase and there phase converter fed DC drives- Drive employing dual converter-Supply Harmonics, Power Factor and Ripple in motor current.

UNIT – III **9**

DC-DC converter Drives: Principles of power control-principle of regenerative brake control - principle of rheostatic brake control-principles of combined regenerative and rheostatic brake control-two and four quadrant DC-DC converter drives-Multi-phase DC-DC converters.

UNIT – IV **9**

Closed loop Control of DC Drives: Open-loop transfer function – closed-loop transfer function-closed –loop control of DC drive-phase locked loop control-microcomputer control of DC drives- Simulation of converter and chopper fed DC drive.

UNIT – V **9**

Traction Drives: Electric Traction services-Nature of traction load-Main line and suburban train configuration –Traction Motors-Traction drives- Traction using converter and chopper controlled DC motors -Solar and battery powered Drives.

List of Experiments :

1. Speed control of DC motor using Three phase Rectifier
2. Analysis of Dual converter fed DC motor drive
3. DSP based chopper drive for DC Motor
4. Simulation of closed loop control of converter fed DC motor
5. Simulation of closed loop control of chopper fed DC motor

Lecture:45, Practical:30,Total: 75

REFERENCES / MANUALS / SOFTWARES:

1. Gopal K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall Inc., New Jersey, 1989.
2. Buxbaum A., Schierau K. and Staughen, "A Design of Control System for D.C.Drives", Springer-Verlag, Berlin, 1990.
3. Krishnan R., "Electric Motor Drives – Modelling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the conventional speed control mechanism for DC motor.	Remembering (K1)
CO2:	Summarize the various control mechanism for AC to DC drives	Understanding (K2)
CO3:	illustrate appropriate control circuit for different quadrant operation	Understanding (K2)
CO4:	make use of digital drives for closed loop operation.	Applying (K3)
CO5:	apply digital drive for traction applications	Applying (K3)
CO6:	analyze and document the performance of converter fed DC drives	Analyzing (K4), Precision (S3)
CO7:	inspect and Observe the performance of DSP based chopper fed DC drives	Analyzing (K4), Precision (S3)
CO8:	select and coordinate the modern digital control technique for speed control of DC motors	Evaluating (K5), Articulation (S4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		1
CO2	3		2
CO3	3		2
CO4	2	1	2
CO5	3	2	2
CO6	2	1	2
CO7	2	1	2
CO8	2	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEC22 SOLID STATE AC DRIVES

L	T	P	Credit
3	0	2	4

Preamble	The objective of the course is to provide concepts about conventional and solid state control techniques for induction and synchronous motor.
Prerequisites	Power Electronics, Electrical Machines, Electric Drives and Control

UNIT – I **9**

Induction Motor Conventional Control: Steady State Performance Equation – Torque Production – Variable Voltage Constant Frequency Operation – Constant Voltage Variable Frequency Operation – Constant Volt/Hz Operation – Rotor Resistance Control – Dahlander Pole Changing Control – Drive Operating Regions – Variable Stator Current Operation – Slip Power Recovery Schemes – Different Braking Methods.

UNIT – II **9**

Induction Motor Solid State Stator Control: AC Voltage Controller Fed Induction Motor Drive – Four Quadrant Operation – Voltage Controller for Pump and Hoist Drives – Six Step Inverter Voltage Control – PWM Inverter – VSI Variable Frequency Drive – Control of IM by CSI – CSI Variable Frequency Drive – Braking and Multi Quadrant Operation of VSI and CSI.

UNIT – III **9**

Induction Motor Solid State Rotor Control: Static Rotor Resistance Control – Injection of Voltage in the Rotor Circuit – Static Scherbius Drives – Power Factor Consideration – Rating and Application – Closed Loop Speed Control – Static Kramer Drive – Modified Kramer Drives – DFIM Drive.

UNIT – IV **9**

Field Oriented Control and Direct Torque Control: Field Oriented Control of Induction Machines – Theory – DC Drive Analogy – Direct and Indirect Methods – Flux Vector Estimation - Direct Torque Control of Induction Machines – Torque Expression with Stator and Rotor Fluxes – DTC Control Strategy.

UNIT – V **9**

Synchronous Motor Drives: Wound Field Cylindrical Rotor Motor – Open Loop Volts/Hertz Control – Self Control Model – Vector Control – Starting and Braking – Load Commutated Synchronous Motor Drives – Brush and Brushless Excitation.

List of Experiments :

1. V/f controlled Induction motor Drive
2. Microcontroller based speed control of VSI fed three phase Induction motor
3. DSP controlled AC drive
4. Analysis of vector controlled Induction motor Drive
5. Condition monitoring of three phase induction motor under fault condition (Simulation)

Lecture:45, Practical:30, Total: 75

REFERENCES / MANUALS / SOFTWARES:

1. Dubey G.K., "Power Semiconductor Controlled Drives", Prentice Hall Inc., A division of Simon and Schester England cliffs, New Jersey, 1989.
2. Bimal K. Bose, "Modern Power Electronics and AC Drives", 2nd Edition, Prentice Hall of India Pvt. Ltd., 2014.
3. Dubey G.K., "Fundamentals of Electric Drives", 2nd Edition, Narosa Book Distributors Pvt. Ltd., 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	classify the performance of conventional speed control techniques	Understanding (K2)
CO2:	explain the solid state stator control techniques for induction motor drive	Understanding (K2)
CO3:	explain the solid state rotor control techniques for induction motor drive	Understanding (K2)
CO4:	evaluate the performance of motor by vector control	Applying (K3)
CO5:	analyze the control technique for synchronous motor	Applying (K3)
CO6:	build and analyze the performance of various induction motor drive	Applying (K3) Manipulation (S2)
CO7:	demonstrate the modern digital control technique for AC drive	Analyzing (K4) Precision (S3)
CO8:	estimate the behavior of induction motor under fault condition	Analyzing (K4) Manipulation (S2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		2
CO2	3		1
CO3	3		1
CO4	3	2	1
CO5	3	2	2
CO6	2	1	2
CO7	2	1	2
CO8	2	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PET21 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

L	T	P	Credit
3	0	0	3

Preamble	This course will cover the applications of power electronics for the control and conversion of electrical power with emphasis on renewable energy systems.
Prerequisites	Electrical Machines, Power Electronics

UNIT – I **9**

Analysis of Solar Energy: Trends in energy consumption - Energy sources and their availability - Photovoltaic Energy Conversion and applications: Solar radiation and measurement - Solar cells and their characteristics - Influence of insolation and temperature - PV arrays - Introduction to flexible solar cells - Electrical storage with batteries.

UNIT – II **9**

Solar Energy Conversion and Applications: Switching devices for solar energy conversion – Array sizing- Boost and buck boost converters - battery sizing - Selection of inverter – Stand alone inverters - Charge controllers - Water pumping and Street lighting-Grid integrated solar system - Design and analysis of PV Systems.

UNIT – III **9**

Analysis of Wind Energy: Basic Principle of wind Energy conversion - Nature of Wind - Power in the wind - Components of Wind Energy Conversion System (WECS) - Performance of Induction Generators for WECS - Classification of WECS- Lightning protection for wind turbine

UNIT – IV **9**

Wind Energy Conversion: Self Excited Induction Generator (SEIG) for isolated Power Generators - Theory of self excitation - Capacitance requirements - Controllable DC Power from SEIGs - Grid connectors concepts - Wind farm and its accessories- Grid related problems - Generator control - Performance improvements - Different schemes - AC voltage controllers - Harmonics and PF improvement.

UNIT – V **9**

Hybrid Systems and Power Converters: Need for Hybrid systems-Wind / Solar PV integrated systems - Selection of power conversion ratio - Optimization of system components - Reliability evolution - Power conditioning schemes: DC Power conditioning Converters - Maximum Power point tracking algorithms - AC Power conditioners - Line commutated inverters -Grid interactive inverters.

Total: 45

REFERENCES:

1. Chetan Singh Solanki, "Solar Photovoltaics : Fundamentals, Technologies and Applications", 2nd Edition, PHI Learning Pvt. Ltd., 2011.
2. Tiwari G., "Fundamentals, Design, Modeling and Applications of Solar Energy", 7th Reprint, Narosa Publishers, 2010.
3. Roger A. Messenger, Jerry Ventre, "Photovoltaic System Engineering", CRC Press, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	summarize the basic characteristics, working and application of PV cells	Understanding (K2)
CO2:	apply the modern power converters for solar PV systems and applications	Applying (K3)
CO3:	explain the working principle of wind energy conversion system	Understanding (K2)
CO4:	identify the components of wind energy conversion system	Applying (K3)
CO5:	show the need for hybrid system and power converters	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		2
CO2	3		3
CO3	3		2
CO4	3		2
CO5	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy

18COE04 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY
(Common to Communication Systems,VLSI Design, Applied Electronics &
Power Electronics and Drives branches)

L	T	P	Credit
3	**0**	**0**	**3**

Preamble	To expose the basics and fundamentals of Electromagnetic Interference and Compatibility in Communication System Design and to know the concepts of EMI Coupling Principles, EMI Measurements and Control techniques and the methodologies of EMI based PCB design.
Prerequisites	Electromagnetic Principles

UNIT – I **9**

EMI Environment: EMI/EMC concepts and definitions, Sources of EMI, conducted and radiated EMI, Transient EMI, Time domain Vs Frequency domain EMI, Units of measurement parameters, Emission and immunity concepts, ESD.

UNIT – II **9**

EMI Coupling Principles: Conducted, Radiated and Transient Coupling, Common Impedance Ground Coupling, Radiated Common Mode and Ground Loop Coupling, Radiated Differential Mode Coupling, Near Field Cable to Cable Coupling, Power Mains and Power Supply coupling.

UNIT – III **9**

EMI/EMC Standards and Measurements: Civilian standards - FCC, CISPR,I EC, EN, Military standards - MIL STD 461D/462, EMI Test Instruments /Systems, EMI Shielded Chamber, Open Area Test Site, TEM Cell, Sensors/Injectors/Couplers, Test beds for ESD and EFT, Military Test Method and Procedures (462).

UNIT – IV **9**

EMI Control Techniques: EMI Control Techniques : Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal Control, Component Selection and Mounting

UNIT – V **9**

EMC Design of PCBs: PCB Traces Cross Talk, Impedance Control, Power Distribution Decoupling, Zoning, Motherboard Designs and Propagation Delay Performance Models.

Total: 45

REFERENCES:

1. Ott W. Henry, "Noise Reduction Techniques in Electronic Systems", 2nd Edition, John Wiley & Sons, New York, 2008.
2. Kodali V.P., "Engineering EMC Principles, Measurements and Technologies", 2nd Edition, IEEE Press, London, 2006.
3. Keiser Bernhard, "Principles of Electromagnetic Compatibility", 3rd Edition, Artech House, Dedham, 1987.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	estimate the EMI and analyze in time domain and frequency domain	Analyzing (K4)
CO2:	compare the various EMI coupling methods	Evaluating (K5)
CO3:	conduct the EMI measurement for civilian and military appliances	Analyzing (K4)
CO4:	device the EMI control techniques	Applying (K3)
CO5:	evaluate the PCB'S and motherboards EMI performance and design the EMC circuits	Creating (K6)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2		
CO2	2		
CO3	3	1	
CO4	2	1	
CO5	2	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18AEE01 DATA COMMUNICATION NETWORKS

(Common to Applied Electronics & Power Electronics and Drives branches)

L	T	P	Credit
3	0	0	3

Preamble	To provide understanding of the concepts of computer networks, multiple access techniques, network protocols, the upper layers of the OSI model, internetworking and emerging trends in networking technologies
Prerequisites	Nil

UNIT – I | **9**

Introduction: Definition of Networks–Classification of Networks–LAN, MAN, WAN, internet–Network Topology – Protocols and Standards – Network Models – OSI, TCP/IP Models of networking – Internet.

UNIT – II | **9**

Physical Layer: Review of Signals–Data Rate Limits–Performance Issues–Bandwidth,Throughput, Latency, Bandwidth-Delay Product, Jitter. Digital Transmission and Analog Transmission: Line coding techniques, PCM and Delta Modulation techniques – ASK, FSK, PSK, and QAM Techniques – Bandwidth Utilization: Multiplexing and Spreading.

UNIT – III | **9**

Communication Media and Data Link Layer: Data Transmission using Telephone Networks–Dial-up MODEMS, Digital Subscriber Line (DSL).Error Detection and Correction techniques:Linear and Cyclic codes–Data Link Control: Framing, Flow and Error Control – HDLC and PPP protocols. Multiple Access Techniques – CSMA, CSMA/CD, CSMA/CA – Channelization – TDMA, FDMA, and CDMA.

UNIT – IV | **9**

Wired LANs and WANs: Wired LANs–IEEE 802 standards - Ethernet–IEEE 802.3 MAC Frame–Token RingLAN - IEEE 802.5 MAC Frame – Wireless LANs – IEEE 802.11 standard – Bluetooth Technology – Interconnection of LANs. Wired WANs - Circuit-Switched Networks, Datagram Networks, Virtual Circuit- switched Networks, Structure of Circuit and Packet Switches - Wireless WANs.

UNIT – V | **9**

Internetworking: Internetworking–tunneling–IP Addressing Scheme–Structure of IP Datagram–IP Routing – TCP as Transport Layer Protocol – Structure of TCP Segment – TCP Connection: Establishment and Closing – SMTP Protocol for E- Mail Application.

Total: 45

REFERENCES:

1. Forouzan Behrouz A., “Data Communications and Networking”, 4th Edition, Tata McGraw-Hill, New Delhi, 2006.
2. Peterson Larry L. and Davie Bruce S., “Computer Networks: A Systems Approach”, 4th Edition, Elsevier Publications, New Delhi, 2007.
3. Rowe Stanford H. and Schuh Marsha L., “Computer Networking”, Pearson Education, New Delhi, 2005.
4. Kurose James and Ross Keith, “Computer Networking: Top Down Approach featuring the Internet”, Pearson Education, New Delhi, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the basic concepts of networking	Understanding (K2)
CO2:	acquire the knowledge of various performance parameters and modulation techniques	Understanding (K2)
CO3:	schedule the network components and the functioning of data link layer	Applying (K3)
CO4:	classify various IEEE standards of wireless networks	Applying (K3)
CO5:	manipulate the addressing scheme and summarize the operations of TCP/IP	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1		
CO2	1		
CO3	1		
CO4	1	1	
CO5	1		

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18AEE03 PROGRAMMABLE LOGIC CONTROLLERS

(Common to Applied Electronics & Power Electronics and Drives branches)

L	T	P	Credit
3	**0**	**0**	**3**

Preamble	The aim of the subject is to develop an understanding of the basic concepts of PLC, advanced PLC programming, installation &troubleshooting and to develop industrial applications.
Prerequisites	Nil

UNIT – I **9**

Introduction to Programmable Logic Controller: Overview of Programmable Logic Controller - Architecture – Principle of operation - I/O Modules: Discrete, Analog, Special – I/O Specifications – CPU – Memory design and types – Programming devices – Recording and Retrieving data –PLC programming languages.

UNIT – II **9**

Basic PLC Programming: Fundamentals of Logic – Program Scan– Relay-Type Instructions - Instruction addressing – Branch and Internal relay instructions – Entering the Ladder diagram – Electromagnetic Control relays – Contactors – Motor Starters – Manual operated switches and Mechanically operated switches.

UNIT – III **9**

Advanced PLC Programming: Programming Timers – Programming Counters – Program Control Instructions – Data Manipulation Instructions – Math Instructions – Sequencer and Shift Register Instructions.

UNIT – IV **9**

PLC Installation and Troubleshooting: PLC Enclosures – Electrical Noise – Leaky Inputs and Outputs – Grounding – Voltage Variations and Surges – Program Editing – Programming and Monitoring – Preventive Maintenance – Connecting PC and PLC.

UNIT – V **9**

PLC Communication and its Applications: Computer Fundamentals – Computer-Integrated Manufacturing – Data Communications – Computer numeric control – Robotics - PLC Applications: Bottle filling system – Pneumatic stamping system – Material handling system – Spray Painting system– Traffic light control system.

Total: 45

REFERENCES:

1. Frank D. Petruzella, "Programmable Logic Controllers" , Tata McGraw-Hill Edition, New Delhi, 2010.
2. Webb John W. and Reis Ronald A., "Programmable Logic Controllers", Prentice Hall Publications, New Delhi, 2005.
3. Bolton W., "Programmable Logic Controllers", Elsevier, New York, 2006.
4. Rockwell Automation, "Logix 5000 Controllers" – system reference

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	identify the PLC hardware and programming languages for various applications	Applying (K3)
CO2:	develop PLC ladder logic programming for industrial problems	Applying (K3)
CO3:	design a PLC system, component, or process to meet a set of specifications	Applying (K3)
CO4:	install and troubleshoot the PLC	Analyzing (K4)
CO5:	apply the PLC in various industrial applications	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	2
CO2	3	1	3
CO3	3	1	3
CO4	3		3
CO5	3		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18AEE06 PROGRAMMABLE DIGITAL SIGNAL PROCESSORS

(Common to Applied Electronics & Power Electronics and Drives branches)

L	T	P	Credit
2	0	2	3

Preamble	This course brings the DSP processors architecture, addressing modes and programming with DSP processors. It also provides an insight to the various types of on-chip peripherals, interfacing methods and various applications.
Prerequisites	Digital Signal Processing, Microprocessors and Microcontrollers

UNIT – I **6**

Architectures of 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, Features for External Interfacing.

UNIT – II **6**

TMS320C5416 Digital Signal Processor: TMS320C5416: Introduction: History Development and Advantages of TMS320 DSPs, Applications. TMS320C5416: Functional Overview Features, Architectural Overview, Pin configuration, Registers, Addressing modes, On-Chip Peripherals, Memory Map, Instruction set. Simple Programs: Addition, Multiplication, Division, Convolution. Introduction to Code Composer studio.

UNIT – III **6**

Interfacing peripherals with TMS320C5416: I/O Interface, ADC Interface, DAC Interface, CODEC Interface. Program: Switch and LED Interfacing, Square wave generation, Saw tooth wave generation**.**

UNIT – IV **6**

TMF28335 Digital Signal Processor: TMF28335 DSP: Overview, Key features: Hardware Features, Software Features, Architecture, Pin configuration, Memory Map, Switches: Boot Load option switch, Processor configuration switch, Power Connector.

UNIT – V **6**

Interfacing peripherals with TMF28334: I/O Interface, ADC Interface, DAC Interface, PWM Module. Programs: Switch and LED interfacing, ADC Port Control, PWM generation.

List of Exercises / Experiments :

1. Generation and Convolution of signals using MATLAB
2. Square Wave form Generation using TMS320C5416 Digital Signal Processor
3. Saw tooth waveform Generation using TMS320C5416 Digital Signal Processor
4. Variable PWM waveform generation using TMF28335 Digital Signal Processor
5. Switch and LED Interfacing using TMF28335 Digital Signal Processor

Lecture:30, Practical:30, Total:60

REFERENCES:

1. Avatar Singh, Srinivasan S., “Digital Signal Processing- Implementation using DSP Microprocessors with Examples from TMS320C54xx”, Thomson India, 2004.
2. Venkataramani B. and Bhaskar M., “Digital Signal Processors, Architecture, Programming and Applications”, 2nd Edition, Tata Mc Graw Hill, 2010.
3. User Manual: VSK5416 & eZdspTMF28335 Technical Reference

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the Basic architectural features of DSP processors	Understanding (K2)
CO2:	describe the various features and programming concepts of TMS320C5416 DSP	Understanding (K2)
CO3:	apply the Interfacing mechanism to interface various peripherals with TMS 320C5416 DSP	Applying (K3)
CO4:	point out the functionality of TMSF28355 DSP	Understanding (K2)
CO5:	employ the Interfacing mechanism of various peripherals with TMS 320C5416 DSP and its programming concepts.	Applying (K3)
CO6:	make use of modern software tool to generate various form of signals	Applying (K3), Manipulation (S2)
CO7:	apply embedded c program for generating waveforms using DSP320C5416	Applying (K3), Manipulation (S2)
CO8:	demonstrate the PWM waveform Generation and I/O interfacing using DSPF28355	Applying (K3), Precision (S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1		
CO2	1		
CO3	2		
CO4	1		
CO5	2	1	
CO6	2	2	1
CO7	3	2	1
CO8	2		

1 – Slight, 2 – Moderate, 3 – Substantial BT - Blooms Taxonomy

18PEE01 PWM TECHNIQUES AND ITS APPLICATIONS

L	T	P	Credit
3	0	0	3

Preamble	This course brings the fundamentals of pulse width modulation techniques and the various types. It is certainly needed for the development of pulses required for the power converters.
Prerequisites	Power Electronics, AC converters

UNIT – I **9**

Fundamentals of PWM: Fundamental Concepts of PWM - Evaluation of PWM Schemes - Double Fourier Integral Analysis of a Two-Level PWM waveform - Naturally Sampled PWM - PWM Analysis by Duty Cycle Variation - Regular Sampled PWM- Direct modulation.

UNIT – II **9**

Programmed Modulation Strategies: Integer versus non integer frequency ratios- Review of PWM variations – Optimized spaced vector PWM- Harmonic elimination PWM - Performance index for optimality - optimum PWM – Minimum loss PWM.

UNIT – III **9**

Modulation of VSI: Topology of a Single Phase Inverter -Three level Modulation of a Single Phase Inverter-Analytic Calculation of Harmonic Losses-Sideband Modulation-Switched Pulse Position-Switched Pulse Sequence - Topology of a Three Phase VSI-Three Phase Modulation with Sinusoidal References.

UNIT – IV **9**

Harmonics and Control: Third Harmonic Reference Injection-Analytic Calculation of Harmonic Losses-Discontinuous Modulation Strategies- Triplen Carrier Ratios and Sub harmonics- Multilevel converter alternatives - Harmonic Elimination applied to multilevel inverters- Minimum Harmonic distortion.

UNIT – V **9**

Space Vector Modulation: Phase Leg References - Naturally Sampled SVM-Analytical Solution for SVM Harmonic Losses for SVM-Placement of the Zero Space Vector-Discontinuous Modulation- SVM for multilevel inverters- discontinuous modulation in multilevel inverters.

Total: 45

REFERENCES:

1. Mohammed H. Rashid, "Power Electronics-Circuits, Devices and Applications", 3rd Edition, Eastern Economy Edition, 2004.
2. Grahame D. Holmes and Thomas A. Lipo, "Pulse width Modulation for Power Converters", IEEE Press series on Power Engineering, Wiley, 2003.
3. Dorin O. Neacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	explain the fundamental concepts of pulse width modulation techniques	Understanding (K2)
CO2:	list the types of pulse width modulation techniques based on its performance index	Understanding (K2)
CO3:	make use of inverter topologies in applying PWM techniques	Applying (K3)
CO4:	explain the strategies involved for harmonic elimination using PWM	Applying (K3)
CO5:	summarize the space vector modulation techniques and its advantages	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		2
CO2	3		2
CO3	3		2
CO4	3	1	2
CO5	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEE02 OPTIMAL CONTROL THEORY

(Common to Power Electronics and Drives & Applied Electronics branches)

L	T	P	Credit
3	1	0	4

Preamble	The objective of the course is to build and analyze models for time varying systems and non linear systems
Prerequisites	System Theory

UNIT – I **9**

Introduction: Review - Models for Time-varying and Nonlinear systems, state space representation, matrix theory, static optimization with and without constraints. Calculus of variations-basic concepts- functional of a single function and several functions - necessary conditions and boundary conditions.

UNIT – II **9**

Optimal Control Formulation: Performance measures for optimal control problems-Hamiltonian approach-necessary conditions for optimal control- Linear regulator problem-infinite time regulator problem-, Regulators with a prescribed degree of stability.

UNIT – III **9**

The Minimum (Maximum) Principle: Pontryagin's minimum principle and state inequality constraints, Minimum time problem, Minimum control energy problems. Singular intervals in optimal control.

UNIT – IV **9**

Numerical Techniques: Numerical solution of two-point boundary value problem –Gradient method and Quasi Linearisation method - solution of Ricatti equation by iterative method.

UNIT – V **9**

Dynamic Programming: Principle of optimality - recurrence relation of dynamic programming for optimal control problem - computational procedure for solving optimal control problems - characteristics of dynamic programming solution - dynamic programming application to discrete and continuous systems - Hamilton Jacobi Bellman equation. Relationship between Dynamic Programming and Minimum Principle.

Lecture:45, Tutorial:15,Total: 60

REFERENCES:

1. Kirk Donald, "Optimal Control Theory", Prentice Hall, New Jersey,1970.
2. Anderson B.D.O. and Moore J.B., "Optimal Control: Linear Quadratic Methods", Prentice Hall, New Jersey, 1979.
3. Desineni Subburam Naidu, "Optimal Control Systems", CRC Press, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	analyze models for time varying systems and non linear systems	Applying (K3)
CO2:	apply the optimal control functions to solve the stability related problems	Applying (K3)
CO3:	analyze the problems using minimum (maximum) principles and numerical techniques	Analyzing (K4)
CO4:	design controllers using various numerical techniques	Analyzing (K4)
CO5:	explain the concept of dynamic programming to solve optimal control problems	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	1	2
CO2	3	1	2
CO3	3	1	2
CO4	3	2	2
CO5	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEE03 SWITCHED MODE POWER CONVERTERS

L	T	P	Credit
3	0	0	3

Preamble	This objective of this course is design and analysis of various electrical power converters.
Prerequisites	Power Electronics

UNIT – I **9**

Resonant Converters: Resonant Converters - Basic resonant circuit concepts – series resonant circuit – parallel resonant circuit – load resonant converter - ZCS resonant converter - L type & M type - ZVS resonant converter – comparison of ZCS & ZVS Resonant Converters.

UNIT – II **9**

Class-E Resonant Converter: Starting States of the Steady State - Time-Domain Steady-State Solutions - Closed-Loop AC and DC Analysis - Type II Amplifier implementation.

UNIT – III **9**

Isolated Converter: Step-Down (Buck)-duty cycle for CCM , DCM in open loop control- voltage and current mode CCM and DCM closed loop control- Push–Pull Converter with Current-Mode Control- Flyback Converters - DCM and DCM Duty-Cycle Determination- Critical Inductance - Voltage-Mode CCM, DCM in Closed Loop - Peak Current-Mode DCM,CCM Closed Loop.

UNIT – IV **9**

Non isolated Converter: Forward Converter- Duty Cycle Determination - Steady-State Closed Loop - Regulation and Output Sensitivity –Boost Converter - Duty-Cycle Determination - Critical Inductance -Peak Current-Mode Closed-Loop Steady State in CCM ,DCM - Output Capacitor Size for CCM ,DCM.

UNIT – V **9**

AC–DC Power-Factor Correction Converter: Fundamental Definition - Single-Phase Single-Stage Nonisolated Boost PFC- Output Capacitor Size – CCM, DCM Boost Inductor Selection - High-Power PFC and Load Sharing - Surge Protection - Load Short-Circuit Protection - Three-Phase PFC.

Total: 45

REFERENCES:

1. Ned Mohan, Undeland and Robbins, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons (Asia) Pvt. Ltd., Singapore, 2003.
2. Rashid M.H., “Power Electronics: Circuits, Devices and Applications”, Pearson Education (Singapore) Pvt. Ltd., Prentice Hall of India, New Delhi, 2004.
3. Keng C.Wu, “Switch-Mode Power Converters: Design and Analysis”, Elsevier, Technology & Engineering, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	interpret the operation of resonant converters for ZVS and ZCS	Understanding (K2)
CO2:	acquire the knowledge about Class-E resonant converter	Understanding (K2)
CO3:	analyze the operation and design parameter for various isolated converter	Understanding (K2)
CO4:	examine the operation and design parameter for various non-isolated converter	Applying (K3)
CO5:	choose a suitable power factor correction methods	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	3
CO2	2		3
CO3	2		3
CO4	2		3
CO5	2	1	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEE04 COMPUTER AIDED DESIGN OF ELECTRICAL MACHINES

L	T	P	Credit
3	1	0	4

Preamble	The objective of the course is to identify the design parameter for electromechanical system using various standard design procedures and development constrain. Apply finite element method and CAD package to design and analysis of various electromechanical systems.
Prerequisites	Electromagnetic Theory, Circuit Theory, Electrical Machines

UNIT – I **9**

Fundamental Aspects and Materials: Introduction – Design Factor – Limitations in Design – Electric Conductivity and Resistivity Materials – Magnetic Material – Insulating Material – Permanent Magnet and Characteristics – Modern design and Manufacturing Techniques

UNIT – II **9**

Principles of Magnetic and Thermal Design: Fundamental of Magnetic Circuit – Magnetizing Curve – MMF in Magnetic Circuit – Real and Apparent Flux Density – Determination of Iron Loss – Modes of Heat Dissipation – Newton's Law of Cooling – Thermal State in Electrical Machine

UNIT – III **9**

Design of DC Motor: Constructional Details – Choice of Flux Density and Ampere Conductor – Main Dimension – Poles and Slots- Design of Field, Armature System and Inter Poles – Design Commutator and Brushes

UNIT – IV **9**

Design of Induction Motor: Constructional Details - Choice of Flux Density and Ampere Conductor – Main Dimension – Stator Design – Rotor Design – Length of Air Gap – Design of Shaft

UNIT – V **9**

Finite Element Modeling and Analysis using ANSYS Software: Preprocessing - Meshing - Material Assigning - Boundary Conditions - Setting up Solution – Post processing - Design of Actuator – DC Motor - Induction Motor – BLDC Motor.

Lecture:45, Tutorial:15, Total: 60

REFERENCES:

1. Sawhney A.K., "Electrical Machine Design", Dhanpat Rai & Co, 2017.
2. Silvester and Ferrari, "Finite Elements for Electrical Engineers", Cambridge University Press, 1983.
3. Hoole S.R.H., "Computer- Aided, Analysis and Design of Electromagnetic Devices", Elsevier, New York, Amsterdam, London, 1989.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	classify and compare the various fundamental aspects and materials used for electrical machines	Understanding (K2)
CO2:	illustrate the principles of magnetic and thermal design for various electrical machines	Applying (K3)
CO3:	identify the design parameter of DC motor by considering load requirement	Applying (K3)
CO4:	identify the design parameter of induction motor by considering load requirement	Applying (K3)
CO5:	design and finite element analysis of various electrical machines using ANSYS software	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2	1	1
CO2	3	2	1
CO3	2	2	1
CO4	3	2	1
CO5	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy

18PEE05 MICROCONTROLLER APPLICATIONS IN POWER ELECTRONICS

L	T	P	Credit
3	0	0	3

Preamble	The objective of the course is to comprehend the microcontroller families, interfacing the peripheral devices with microcontroller and its programming concepts for designing Power Electronics based applications
Prerequisites	Microprocessors and Microcontrollers, Power Electronics

UNIT – I **9**

Introduction To Microcontroller: Evolution of microcontrollers –comparison between microprocessor and microcontrollers –Embedded systems and their characteristics – steps in Designing microcontroller based system - Instruction pipelining & advanced concepts. Architecture and programming Intel 8051, and PIC mid range microcontroller –Different types of addressing modes. Selection of Microcontrollers for suitable application and clock pulse generation.

UNIT – II **9**

Input Interfacing Device: Interfacing LCD Display –Keypad Interfacing –Controlling DC/ AC appliances – Measurement of frequency Stand alone Data Acquisition System-Interfacing external hardware like Driver Ics, sensors and actuators –Practical aspects-Interfacing of relay circuit-Interfacing of 7 segment LED displays-Interfacing Matrix keyboards

UNIT – III **9**

Output Interfacing Device: Measurement of voltage, current, and speed, power and power factor using microcontrollers-Power quality/power factor correction - AC load control –-Motor Control-PID control of DC motor –stepper motor control –brush less DC motor control. Practical Aspects-Implementation in electromechanical system for stepper motor-Typical applications in the control of power electronic converter for power supplies

UNIT – IV **9**

Microcontrolles in Power Electronics: Gate firing control of converters and inverters -PWM implementation - Feedback control and processing of feedback signals-Implementation of digital controllers and filters-Monitoring, sequencing, diagnostics and miscellaneous computation and control-Control of AC/DC electric drives-Solar Power Conditioning (MPPT)-Remote Control-UPS Applications.

UNIT – V **9**

I/O Programming: Software Debugging-Hardware Test-Assembly language programming for -Zero crossing detectors –square wave generation -firing pulse generation for typical single-phase andThree Phase converters and inverters -ADC program-PWM Techniques.

Total: 45

REFERENCES:

1. Martin P. Bates, “Interfacing PIC Microcontrollers: Embedded Design by Interactive Simulation”, 2nd Edition, Newness Publisher, 2013.
2. Mazidi and Mazidi, “The 8051 Microcontroller and Embedded Systems”, 5th Edition, Pearson Education Indian Reprint, 2003.
3. Kenneth Ayala, “The 8051 Microcontroller and its Programming”, Thomson-Delmar Learning, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the basics concepts in microcontroller	Understanding (K2)
CO2:	illustrate the interfacing of input devices with microcontroller	Understanding (K2)
CO3:	illustrate the interfacing of output devices with microcontroller	Understanding (K2)
CO4:	apply the knowledge of microcontroller in power electronics based applications	Applying (K3)
CO5:	develop an ALP for power electronic based applications	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		1
CO2	3		1
CO3	3		1
CO4	3	1	2
CO5	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEE06 POWER QUALITY ENGINEERING

L	T	P	Credit
3	0	0	3

Preamble	The objective of the course is to provide knowledge about various power quality problems, effects and improvement techniques.
Prerequisites	Power Quality, Power Electronics for Renewable Energy Systems

UNIT – I **9**

Power Quality Definitions and Fundamentals of Harmonics: Introduction – Power Quality definitions: Transients, Short Duration and Long Duration Voltage variations, Voltage imbalance, Waveform distortion, Voltage fluctuations. Power frequency disturbances: curves for low frequency disturbances – voltage tolerance criteria - power acceptability curves (CBEMA and ITI). – Introduction to Harmonic standards.

UNIT – II **9**

Waveform Distortions: Harmonic indices, inter-harmonics, voltage unbalance, flicker, Harmonic sources from commercial and industrial loads, Standards on harmonics. System response characteristics: System impedance, capacitor impedance, parallel resonance, series resonance loads, effects of resistance and resistive load. Effects of harmonic distortion: Impact on capacitors, transformers, motors and telecommunication circuits – Guidelines for voltage and current harmonics limitations.

UNIT – III **9**

Waveform Processing Techniques and Monitoring: Fundamental frequency characterization: Curve – fitting algorithm, implementation, frequency estimation, R.M.S Error assessment, Fourier analysis: Convolution of harmonic phasors, sampled time functions, DFT, Efficiency of FFT algorithms, Wavelet transform, automation of disturbance reorganization.

UNIT – IV **9**

Wiring, Grounding and Power Quality Measurement Equipment: Definitions- National Electrical Code Grounding Requirements - Reasons for grounding. Typical Wiring and grounding problems: Problems with conductors and connectors, missing safety ground, multiple neutral-to-ground connections, ground loops, Solutions to wiring and grounding problems: proper grounding practices, Rod, separately derived systems. Grounding techniques for signal reference – Types of instruments, wiring and grounding testers, disturbance analyzers, spectrum and harmonic analyzer, flicker meter, smart power quality monitor – number of test locations – test duration of measurement.

UNIT – V **9**

Power Quality Assessment, Improvement and Harmonic Filters: Assessment of power quality measurement data: Off – line, On – line data assessment, Application of Intelligent systems – Active, Passive and Hybrid filters. Custom power Devices: Network reconfiguring devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC. Control strategies: P – Q theory, Synchronous detection method.

Total: 45

REFERENCES:

1. Dugan C. Roger, “Electrical Power Systems Quality”, 3rd Edition,Tata McGraw Hill, New Delhi, 2012.
2. Arillaga J., “Power System Quality Assessment”, Wiley India Pvt. Ltd., New Delhi, 2011.
3. Sankaran C., “Power Quality”, CRC Press, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	explain the concepts of different power quality indices	Understanding (K2)
CO2:	classify the types of waveform distortions and its impact on various loading condition	Understanding (K2)
CO3:	apply different waveform processing techniques for power quality improvement	Applying (K3)
CO4:	identify the wiring and grounding problems and explain the different types of PQ measuring instruments	Understanding (K2)
CO5:	assess the power quality using filters and custom power devices	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	1	2
CO2	2	2	2
CO3	3	1	2
CO4	3	2	2
CO5	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEE07 SMART GRID

L	T	P	Credit
3	0	0	3

Preamble	The aim of the course is to provide basic concept of history, challenges, future scope, infrastructure, available computational tools, communications and its standards in smart grids
Prerequisites	Power System Operation and Control

UNIT – I **9**

Smart Power Grids: Introduction - Todays Grid Challenges - Background and History of Smart Power Grid Evolution - Definition, Characteristics and Benefits of Smart Grid-Vision and its Realisation - Architectural and Functional Concepts-Examples of SG projects in India- Outline of US Effort, Europe effort and China Effort - Research Issues.

UNIT – II **9**

Smart Grid Infrastructure: Composition of Smart Grid based on: Standards adaptation, technical and Technical Components perspective, Conceptual reference model Perspective, Basic components of smart grid and its technical infrastructure.

UNIT – III **9**

Computational Tools for Smart Grid: Introduction -Decision Support Tools (DS) - Optimization Techniques- Classical Optimization Methods-Heuristic Optimization- Evolutionary Computational Techniques -Adaptive Dynamic Programming Techniques- Pareto Methods - Hybridizing Optimization Techniques and Applications to the Smart Grid -Computational Challenges

UNIT – IV **9**

Communications and Standards: Communication and Measurement ,Monitoring, PMU, Smart Meters, and Measurements Technologies ,Multiagent Systems (MAS) Technology .Standards: Approach to Smart Grid Interoperability Standards ,Synchrophasor Standards IEEE 1548,IEC 61850, IEEE C37.118,IEEE C37.242,IEEE C37.238,IEEE C37.244,C37.247.

UNIT – V **9**

Case studies and Test Beds for Smart Grids: Demonstration Projects**,** Advanced Metering , Micro grid with Renewable Energy ,Power System Unit Commitment (UC) Problem, ADP for Optimal Network Reconfiguration in Distribution Automation ,Case Study of RER Integration ,Testbeds and Benchmark Systems, Challenges of Smart Transmission, Benefits of Smart Transmission, Introduction to Smart grid Distribution Systems.

Total: 45

REFERENCES:

1. Janaka Ekanayake, Nick Jenekins, “Smart Grid: Technology and Applications”, John Wiley and Sons, Canada, 2011.
2. James Mamoh, “Smart Grid Fundamentals of Design and Analysis”, IEEE Press, John Wiley and Sons, Canada, 2012.
3. IEEE respective Standards, IEEE Press.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the basics of smart grid and its issues	Understanding (K2)
CO2:	explain the smart grid infrastructure and its composition	Understanding (K2)
CO3:	identify the computational methods and tools associated with it.	Applying (K3)
CO4:	make use of the communication protocols and standards associated with it.	Applying (K3)
CO5:	develop the case studies for specified problem, test bench and its benchmark system.	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		2
CO2	3		2
CO3	3	3	2
CO4	3	2	2
CO5	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEE08 SPECIAL ELECTRICAL MACHINES AND CONTROL

L	T	P	Credit
3	0	0	3

Preamble	The aim of the course is to provide knowledge about construction, working of Special Electrical Machines and its applications.
Prerequisites	DC Machines, AC Machines

UNIT – I **9**

Permanent Magnet Synchronous Motors – Classification – Construction - Principle of operation – EMF and torque equations – Phasor diagram – Locus diagram –Power controllers – Converter Volt-ampere requirements – torque speed characteristics – Microprocessor based control.

UNIT – II **9**

Synchronous Reluctance Motors – Constructional features – Types – Axial and Radial motors – Operating principle – Reluctance torque – Torque equation – Phasor diagram – Characteristics – Introduction to Vernier motor – Construction and Operating principle.

UNIT – III **9**

Permanent Magnet Brushless D.C. Motors: Construction – Principle of operation – Types – Comparison between conventional DC and PMBLDC – Electronic commutation – EMF and torque equations – Speed Torque relations – Rotor position Sensors – Power controllers – Motor characteristics and Computer control

UNIT – IV **9**

Switched Reluctance Motors: Constructional features – Principle of operation – Torque prediction – Inductance profile – Simple Application problems – Analysis – Types of Power controllers and converter topologies – Current control schemes – Torque Speed Characteristics – Hysteresis and PWM – Phase current analysis for low, Medium and High speed operation – Microprocessor based control.

UNIT – V **9**

Stepping Motors: Constructional features – Types – Principle of operation – Permanent Magnet motor – Variable reluctance motor – Hybrid motor – Single and multi-stack configurations – Theory of torque predictions – Characteristics – Simple problems.

Total: 45

REFERENCES:

1. Miller T.J.E., “Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, Oxford, 1989.
2. Aearnley P. P., “Stepping Motors - A Guide to Motor Theory and Practice”, Peter Perengrinus, London, 1982.
3. Kenjo T. and Nagamori S., “Permanent Magnet and Brushless DC Motors”, Clarendon Press, London, 1988.
4. Kenjo T., “Stepping Motors and Their Microprocessor Controls”, Clarendon Press, London, 1984.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	explain the construction, operation and performance of permanent magnet synchronous motor	Understanding (K2)
CO2:	explain the construction, principle of operation and characteristics of synchronous reluctance motors	Understanding (K2)
CO3:	compare permanent magnet brushless DC motor with conventional DC motor and analyze its performance	Analyzing (K4)
CO4:	explain the construction, principle of operation of switched reluctance motor and analyze its performance	Analyzing (K4)
CO5:	classify the stepper motor and summarize the operation and characteristics of stepper motor	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2		2
CO2	2		2
CO3	3	1	2
CO4	3	1	2
CO5	2		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy

18MTE13 MEMS DESIGN

(Common to Mechatronics, CADCAM, Engineering Design, VLSI Design, Applied Electronics, Power Electronics and Drives & Control and Instrumentation Engineering branches)

L	T	P	Credit
3	0	0	3

Preamble: This course equips the students to understand the concepts of Micro mechatronics and apply the knowledge of micro fabrication techniques for various applications.

Prerequisites: Sensors and Instrumentation and Bridge course mechanical

UNIT – I **9**

Materials for MEMS and Scaling Laws: Overview - Microsystems and microelectronics - Working principle of Microsystems - Si as a substrate material - Mechanical properties - Silicon compounds - Silicon piezo resistors - Gallium arsenide - Quartz-piezoelectric crystals - Polymer - Scaling laws in Miniaturization.

UNIT – II **9**

Micro Sensors, Micro Actuators: Micro sensors - Micro actuation techniques - Micro actuators – Micromotors – Microvalves – Micro grippers – Micro accelerometer: introduction, types, actuating principles, design rules, modeling and simulation, verification and testing, applications.

UNIT – III **9**

Mechanics for Microsystem Design: Static bending of thin plates - Mechanical vibration - Thermo mechanics - Thermal stresses - Fracture mechanics - Stress intensity factors, fracture toughness and interfacial fracture mechanics-Thin film Mechanics-Overview of Finite Element Stress Analysis.

UNIT – IV **9**

Fabrication Process and Micromachining: Photolithography - Ion implantation - Diffusion – Oxidation – CVD - Physical vapor deposition - Deposition by epitaxy - Etching process- Bulk Micro manufacturing - Surface micro machining – LIGA –SLIGA.

UNIT – V **9**

Micro System Design, Packaging and Applications: Design considerations - Process design - Mechanical design – Mechanical Design using Finite Element Method-Micro system packaging – Die level - Device level - System level – Packaging techniques - Die preparation - Surface bonding - Wire bonding – Sealing - Applications of micro system in Automotive industry: Bio medical, Aerospace and Telecommunications – CAD tools to design a MEMS device.

Total: 45

REFERENCES:

1. Tai-Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata McGraw-Hill, New Delhi, 2008.
2. Mohamed Gad-el-Hak, “The MEMS Handbook”, CRC Press, 2009.
3. Bao M.H., “Micromechanical Transducers: Pressure sensors, accelrometers, and gyroscopes”, Elsevier, New York, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	interpret the concepts of MEMS materials and scaling laws	Remembering (K1)
CO2:	explain the principles of micro sensors and actuators	Understanding (K2)
CO3:	apply the mechanics for micro system design	Applying (K3)
CO4:	design and fabrication of microsystem	Applying (K3)
CO5:	design of microsystem packaging and application	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2		2
CO2	2		2
CO3	3		3
CO4	3		3
CO5	3		3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy BT – Blooms Taxonomy

18CIE15 VIRTUAL INSTRUMENTATION FOR INDUSTRIAL APPLICATIONS

(Common to Control and Instrumentation Engineering, Embedded Systems, Applied Electronics & Power Electronics Drives branches)

L	T	P	Credit
3	0	0	3

Preamble	To impart knowledge about advanced tools in virtual instrumentation to develop new industrial applications
Prerequisites	Virtual Instrumentation

UNIT – I **9**

Graphical System Design Programming Concepts: G-Programming- debugging techniques-Loops: For loop, While Loop, Shift registers-Structures: Case Structure, Sequence Structure, Event Structure, Timed Structure-

UNIT – II **9**

Data Acquisition and Interfacing: Data Acquisition in LabVIEW-Hardware installation and configuration-DAQ components-DAQ signal Accessory-DAQ Assistant-DAQ Hardware-DAQ Software.

UNIT – III **9**

GSD Programming Toolkits: Signal Processing and Analysis-Control System Design and Simulation-Digital Filter Design-Spectral Measurements-Report generation-PID Control-Biomedical Startup kit.

UNIT – IV **9**

VI Applications Part I: Material Handling System **-**Fiber-Optic Component Inspection Using Integrated Vision and Motion Components-Internet-Ready Power Network Analyzer for Power Quality Measurements and Monitoring.

UNIT – V **9**

VI Applications Part II: Developing Remote Front Panel LabVIEW Applications- Using the Timed Loop to Write Multirate Applications in LabVIEW - Client–Server Applications in LabVIEW- Neural Networks for Measurement and Instrumentation in Virtual Environments.

Total: 45

REFERENCES:

1. Jovitha Jerome, "Virtual Instrumentation using LabVIEW", 3rd Edition, PHI Learning Pvt. Ltd., New Delhi, 2012.
2. Sumathi S., Surekha P., "LabVIEW based Advanced Instrumentation Systems", Springer Science & Business Media, 2007.
3. Sanjay Gupta, Joseph, John, "Virtual Instrumentation using LabVIEW", 2nd Edition, Tata McGraw Hill, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	apply structured programming concepts in developing VI programs and employ various debugging techniques	Applying (K3)
CO2:	interface hardware devices with software using DAQ system	Applying (K3)
CO3:	design, implement and analyze an application using different tools	Applying (K3)
CO4:	apply knowledge on various tools in practical works	Applying (K3)
CO5:	create virtual instruments for real time applications	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1		1
CO2	2		2
CO3	2		2
CO4	2		1
CO5	2		2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy BT – Blooms Taxonomy

18AEE07 ENERGY CONSERVATION, MANAGEMENT AND AUDITING

(Common to Applied Electronics & Power Electronics and Drives branches)

L	T	P	Credit
3	0	0	3

Preamble	The aim of the course is to understand the basics of energy conservation techniques, energy auditing in industries and the associated economical benefits.
Prerequisites	Nil

UNIT – I **9**

Energy: Energy Scenario – India and World – Energy Resources Availability in India– Energy consumption – Pattern, Energy and Environment - Energy Security - Energy Conservation and its importance, Energy Conservation Act, 2001 and its features

UNIT – II **9**

Energy Conservation in Thermal Systems: Energy Conservation in Thermal Systems – Needs and Advantages. – Properties of steam –Assessment of steam distribution losses, steam leakages, steam trapping, Various Energy Conservation measures in Steam Systems – Losses in Boilers, Energy Conservation opportunities in Boilers

UNIT – III **9**

Energy Management: Importance of Energy Management, Financial analysis Techniques – Simple Payback Period, Return on Investment, Net present Value, Internal Rate of Return, Cash flows, Risk and Sensitivity Analysis, Financing Options, Energy Performance Contract and Role of ESCOS.

UNIT – IV **9**

Energy Efficient technologies in Electrical System: Maximum Demand Controllers, Automatic Power Factor Controllers, Energy Efficient motors, Soft starters with Energy Saver, Variable speed drives, Energy Efficient transformers, Electronic Ballast, Energy Efficient Lighting Controls- Occupancy Sensors, Time based control.

UNIT – V **9**

Energy Audit: Energy Audit – Need, Principle, Types, Methodologies, Energy audit approach, Barriers, Role of Energy Manager and Auditor – Energy Audit Questionnaire – Bench marking and Energy Performance – Energy Audit Instruments, Case study.

Total: 45

REFERENCES:

1. "Book I - General Aspect of Energy Management and Energy Audit", 3rd Edition, Bureau of Energy Efficiency, Ministry of Power, India, 2010,
2. "Book II - Energy Efficiency in Thermal Utilities", 3rd Edition, Bureau of Energy Efficiency, Ministry of Power, India, 2010.
3. "Book III - Energy Efficiency in Electrical Utilities", 3rd Edition, Bureau of Energy Efficiency, Ministry of Power, India, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	outline the energy scenario	Understanding (K2)
CO2:	apply the energy performance measures in thermal system	Applying (K3)
CO3:	apply various financial techniques for economic analysis	Applying (K3)
CO4:	apply the energy performance measures in electrical system	Applying (K3)
CO5:	explain the principles and methodologies of energy audit	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2		
CO2	3	2	2
CO3	3	3	2
CO4	3	2	2
CO5	2	1	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy BT – Blooms Taxonomy

18AEE08 PROJECT MANAGEMENT 3003
(AE, PED)

18AEE08 PROJECT MANAGEMENT
(Common to Applied Electronics & Power Electronics and Drives branches)

L	T	P	Credit
3	0	0	3

Preamble	This course serves as a guide to learn and execute various phases of undertaking a project.
Prerequisites	Nil

UNIT – I **9**

Philosophy and Concepts: Need – Goals- Evolution-Different Forms -Project Management in Manufacturing, Service and Government Sectors; Systems Development Cycle – Conception phase: proposal, contracting – Definition phase – Execution phase: production / build, implementation – Operation phase- System Development in Industries, service and government sectors - case study.

UNIT – II **9**

Planning Fundamentals: Planning Steps – Project master plan - Tools for project planning – work break down structure, responsibility matrix, events and mile stones- Gantt charts. Network Scheduling – the critical path – early and late times – slack –float – calendar scheduling.

UNIT – III **9**

PERT: Time estimates – probability of finishing by target completion date – criticisms of PERT - CPM – Time cost relationship – reducing project duration – shortest duration – total project cost; Scheduling with Resource Constraints – resource loading and leveling – constrained resources; Introduction to GERT network - case studies in PERT/CPM.

UNIT – IV **9**

Project Cost Estimation: Process – classification-expert opinion, analogy estimate, parametric estimate, cost engineering, Contingency amount - Elements of budgets and Estimates – direct labour, direct non- labour, overhead, general and administrative expenses, profit and total billing. Project cost accounting – budgeting using cost accounts - cost summaries, cost schedules and forecasts – case study. Project Management Information Systems (PMIS): Functions – Computer based PMI Systems – Web-Based project management

UNIT – V **9**

Project Control: Cost accounting systems- project control process - Project control emphasis- Performance Analysis – cost, schedule, work package analysis, performance indices, updating time estimates, technical performance measurement- Performance Index monitoring – variance limits, controlling changes, contract administration, control problems, case study. Project Evaluation: Review meetings, reporting, terminating, termination responsibilities, closing the contract, project extensions, project summary evaluation.

Total: 45

REFERENCES:

1. Nicholas John M., “Project Management for Business and Technology”, Prentice Hall India, New Delhi, 2011.
2. Pagnoni Anastasia, “Project Engineering: Computer Oriented Planning and Operational Decision Making”, Springer-Verlag, Berlin, 2012.
3. Pannerselvam R., “Project Management”, PHI Learning Pvt. Ltd., 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	understanding of a schematic carrying out a project indicating various phases	Understanding (K2)
CO2:	apply project management techniques for executing projects	Applying (K3)
CO3:	understand various control measures in project implementation	Understanding (K2)
CO4:	analysis the techniques and procedures for defining, scheduling and budgeting project activities to achieve project quality, time, and cost goals.	Evaluating (K5)
CO5:	monitor, evaluate, control and executing the project.	Evaluating (K5)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1		
CO2	2	1	
CO3	1		
CO4	2	1	
CO5	2	1	

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy BT – Blooms Taxonomy

18AEE10 SCADA AND DCS

(Common to Applied Electronics & Power Electronics and Drives branches)

L	T	P	Credit
3	0	0	3

Preamble	The aim of the subject is to develop an understanding of the basic concepts of automation system using SCADA & DCS and to develop the industrial applications using the same.
Prerequisites	Digital Logic Circuits

UNIT – I **9**

Automation: Fundamentals of industrial automation, need and role of automation, evolution of automation. HMI systems, Text display – operator panels – Touch panels – Panel PCs – Integrated displays (PLC and HMI), Rack installation, Grounding and shielding, physical, electrical, maintenance requirements-Troubleshooting.

UNIT – II **9**

SCADA: Concept of SCADA systems, Programming techniques for : Creation of pages, Sequencing of pages, Creating graphics and animation, Dynamos programming with variables, Trending, Historical data storage and Reporting, Alarm management, reporting of events and parameters. Comparison of different SCADA packages. Application Development using SCADA system.

UNIT – III **9**

DCS Introduction: Location of DCS in Plant, functions, advantages and limitations, Comparison of DCS with PLC. DCS components/ block diagram, Architecture, Functional requirements at each level. Layout of DCS, Controller Details, Redundancy, I/O Card Details, Junction Box and Marshalling Cabinets.

UNIT – IV **9**

Distributed Control System: Distributed Control Systems (DCS) – Difference between SCADA system and DCS – local control unit – programming language – communication facilities – operator interface – engineering interfaces.

UNIT – V **9**

Applications: Applications of SCADA and DCS – Case studies of Process plants using SCADA and DCS – Advanced features / options in SCADA and DCS – Role of PLC in DCS and SCADA – comparison – field devices (Transducers, drives etc) in DCS / SCADA.

Total: 45

REFERENCES:

1. Lukas Michael P., “Distributed Control Systems”, Van Nostrand Reinfold Company, 2002.
2. Dobrivojie Popovic and Vijay P. Bhatkar, “Distributed Computer Control for Industrial Automation”, CRC Press, 1990.
3. CIMPLICITY SCADA Packages Manual Fanuc India Ltd., 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	demonstrate the basic concepts on automation system	Understanding (K2)
CO2:	develop programming with SCADA system	Applying (K3)
CO3:	compare and explain the basic concepts of DCS and SCADA	Applying (K3)
CO4:	develop a DCS and SCADA system for a process to meet a set of specifications	Applying (K3)
CO5:	apply the SCADA and DCS in various industrial applications	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	1		
CO2	3	2	3
CO3	1		
CO4	3	2	3
CO5	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEE09 MODERN POWER SYSTEM PROTECTION

L	T	P	Credit
3	0	0	3

Preamble	The objective of the course is to provide knowledge about the need of protection, operation of relays and its modern trend
Prerequisites	Power System Protection and Switch Gear

UNIT – I **9**

Introduction: General philosophy of protection – Characteristic functions of protective relays – basic relay elements and relay terminology – Classification of Relays – Construction and operation of Electromagnetic relays – A review of conventional protection schemes for Transmission lines and station apparatus (Qualitative treatment only)

UNIT – II **9**

Static Relays: Solid state devices used in static protection – Amplitude comparator and phase comparator – Static Over current relays: Non-directional, Directional - Synthesis of Mho relay, Reactance relay, Impedance relay and Quadrilateral Distance relay using Static comparators, Differential relay.(Qualitative treatment only)

UNIT – III **9**

Microprocessor Based Relays: Hardware and software for the measurement of voltage, current, frequency, phase angle – Microprocessor implementation of over current relays – Inverse time characteristics – Directional relay – Impedance relay– Mho relay, Differential relay – Numerical relay algorithms – SCADA Architecture, Use of SCADA in interconnected power systems - Interfacing.(Qualitative treatment only)

UNIT – IV **9**

DSP and traveling wave relays: Introduction to Digital Signal Processing - Logic devices and systems – Signal Processing Filters – DSP based relays – DSP based Algorithms - Traveling wave relays: Amplitude comparison relay, phase comparison relay, Directional comparison relay, Fault location. (Qualitative treatment only)

UNIT – V **9**

Modern Trends in Protective Relaying: Pilot relay protection: Wire pilot relaying, Carrier current pilot relaying, Microwave pilot relaying – Fibre-optic based relaying – Apparatus Protection: Digital protection of generators, Digital protection of Transformers – Protection of Long and short lines– Application of Artificial Intelligence to power system protection – (Qualitative treatment only)

Total: 45

REFERENCES:

1. Paithankar Y.G., Bhide S.R., “Fundamentals of Power System Protection”, Prentice Hall India, 2011.
2. Badri Ram and Vishwakarma D.N., “Power System Protection and Switchgear”, Tata McGraw Hill, New Delhi, 2011.
3. Blackburn J.L., “Protective Relaying: Principles and Applications”, CRC Press Inc., 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	recall the basic concepts of protective schemes and relays	Understanding (K2)
CO2:	explain the importance of Static relays	Understanding (K2)
CO3:	apply the microprocessor concepts in relays for various industrial applications	Applying (K3)
CO4:	develop algorithms for DSP and travelling wave relays	Applying (K3)
CO5:	categorize the various concepts of modern trends in protective relaying	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		2
CO2	3		2
CO3	3	2	2
CO4	3	2	2
CO5	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEE10 COMPUTER AIDED SIMULATION AND DESIGN OF POWER ELECTRONIC SYSTEMS

L	T	P	Credit
3	0	0	3

Preamble	The ultimate intention of this subject is to model/simulate various types of power semiconductors, electrical machines and power electronics for their role in monitoring, controlling and conversion of energy.
Prerequisites	Electron Devices, Power Electronics

UNIT – I **9**

Introduction: Importance of simulation – Challenges in simulation -General purpose circuit analysis – Methods of analysis of power electronic systems – Review of power electronic devices and circuits. **PSpice :** File formats - Description of circuit elements - Circuit description – Output variables - Dot commands - SPICE models of Diode, Thyristor, Triac, Power MOSFET, IGBT and MCT. **MATLAB and Simulink :** Toolboxes of MATLAB - Programming and file processing in MATLAB – Model definition and model analysis using SIMULINK - S-Functions - Converting S Functions to blocks.

UNIT – II **9**

Method for Transient Simulation: Introduction, Numerical methods for solving ODEs, Stability of numerical methods. Stiff equations, Adaptive step size, Transient analysis in circuit simulation, Equivalent circuit approach, and practical aspects.

UNIT – III **9**

Modeling and Simulation of Power Electronic Devices and Machines: Modeling of Diode, SCR, TRIAC, IGBT and Power Transistors and their simulation - Simulation of gate/base drive circuits, simulation of snubber circuits. State space modeling and simulation of linear systems - Electrical machines modeling and its simulation: DC, Induction and synchronous machines

UNIT – IV **9**

Simulation of Converters: Diode rectifiers -Controlled rectifiers - AC voltage controllers - DC choppers – PWM inverters – waveform control - Voltage source and current source inverters - Space vector representation - Resonant pulse inverters - Zero current switching and zero voltage switching inverters.

UNIT – V **9**

Simulation of Drives: Block diagram of an electric drives - Rectifier fed DC motors – Chopper fed DC motors Simulation of closed loop speed control schemes for DC motors — VSI and CSI fed AC motors – DC link inverter - Simulation of power factor correction schemes.

Total: 45

REFERENCES:

1. Chee-Mun Ong, “Dynamic Simulation of Electric Machinery: Using MATLAB/ Simulink”, Prentice Hall PTR, New Jersey, 1998.
2. Partha S. Mallick, “MATLAB and SIMULINK: Introduction to Applications”, Scitech Publications (India), 2006.
3. Rashid H. Muhammad, “Introduction to PSPICE using Orcad for Circuits and Electronics”, 3rd Edition, Pearson/Prentice Hall, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	choose suitable software package for power electronic circuits analysis	Understanding (K2)
CO2:	interpret application of numerical methods for transient response	Understanding (K2)
CO3:	model various semiconductor and electrical machines in SIMULINK environment	Applying (K3)
CO4:	analyze different types of power electronic circuits	Analyzing (K4)
CO5:	choose a suitable drives for industrial application	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3	1	3
CO2	3	2	2
CO3	3	3	3
CO4	3	3	3
CO5	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEE11 EMBEDDED SYSTEM AND APPLICATIONS

L	T	P	Credit
3	0	0	3

Preamble	This course is introduced to comprehend the microcontroller family and its programming concepts for designing & controlling a real time embedded system.
Prerequisites	Microprocessors and Microcontrollers

UNIT – I **9**

Introduction: Introduction to Embedded systems – Von Neumann and Harvard architecture – Need of Microcontrollers – selection criterion - PIC Microcontroller 16F87X: Architecture – Features – Resets – Memory Organizations: Program Memory, Data Memory – Instruction Set – Simple programs using Assembly language Instruction sets – Interrupts.

UNIT – II **9**

Physical Interface Support using PIC: PIC Peripherals – I/O Parallel Ports – Timers – Capture/Compare/PWM (CCP) Modules - Control registers – Serial ports – Master Synchronous serial Port (MSSP) in I^2C mode and in SPI mode – USART – Interfacing of PIC: Analog-to-digital Converter (ADC) – Registers associated with the peripherals – Initializing the Peripheral modules using Assembly language.

UNIT – III **9**

ARM Processor and Programming: General concepts - ARM7 - Instruction Set Architecture, Levels in architecture, Functional description - processor and memory organization - Introduction to RISC architecture, pipelining, Instruction issue and execution - Instruction formats - Addressing modes - Data alignment and byte ordering – Simple programs using Assembly language Instruction sets.

UNIT – IV **9**

Embedded System Interfaces: Sensors – Actuators – Interfacing LCD Display – Keypad Interfacing - Relays – Seven segment Display – Organic LED – Optocoupler - Motor Control – H-bridge control – Stepper motor control - Controlling DC/AC appliances.

UNIT – V **9**

System Design and Case Study Applications: Generation of Gate signals for converters and Inverters – Measurement of frequency - Standalone Data Acquisition System – Automatic Vehicle Accident Alert System - Brain Machine Interface (BMI).

Total: 45

REFERENCES:

1. Ajay V. Deshmukh, “Microcontrollers: Theory and Applications”, Tata McGraw Hill, New Delhi, 2007.
2. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey, “PIC Microcontroller and Embedded Systems using Assembly and C for PIC18”, Pearson Education, 2008.
3. Wayne Wolf, “Computers as Components: Principles of Embedded Computing System Design”, 2nd Edition, Morgan Kaufman Publishers, San Francisco, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	illustrate the basic architecture and demonstrate the interfacing concepts of PIC16 microcontroller	Understanding (K2)
CO2:	apply the programming skills for peripheral interfacing and real time applications	Applying (K3)
CO3:	illustrate the basic architecture and demonstrate the interfacing concepts of arm processor	Understanding (K2)
CO4:	analyze the various interfaces for the embedded control	Applying (K3)
CO5:	apply the system design concepts for various applications	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		2
CO2	3		2
CO3	3	1	2
CO4	3	2	2
CO5	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom’s Taxonomy

18PEE12 HYBRID ELECTRIC VEHICLE SYSTEMS

L	T	P	Credit
3	0	0	3

Preamble	This course is aimed to introduce the fundamental concepts, principles and various drive train topologies of electric and hybrid electric vehicles.
Prerequisites	Power Electronics, Electrical Machines

UNIT – I 9

Introduction to HEV: History of hybrid and electric vehicles - social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies- Basics of vehicle performance - Dynamics, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

UNIT – II 9

Hybrid Traction: Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies- power flow controls in hybrid drive-train topologies - Basic concept of electric traction- Introduction to various electric drive-train topologies- fuel efficiency analysis.

UNIT – III 9

Series and Parallel Hybrid Drive Train: Configuration of series drive train – Operating modes – Control Strategies – Max. SOC-of-PPS Control Strategy - Thermostat Control Strategy (Engine-On–Off) - Configuration of parallel drive train – Objectives – Control Strategies – Max. SOC-of-PPS Control Strategy - Engine Turn-On and Turn-Off (Engine-On–Off) Control Strategy – Fuel Cell Hybrid Electric vehicle.

UNIT – IV 9

Battery Technologies for Electric Vehicle: Introduction - Power and Energy of Electric Propulsion - Basic Terms of Battery Performance and Characterization - Battery Charging Methods and EV Charging Schemes: Charging Methods - EV Charging Schemes - Basic Operation of a Rechargeable Battery - Battery Modeling - Current Status of Battery in Automobile Applications

UNIT – V 9

Control of DC and AC Vehicle Drives: DC/DC chopper based four quadrant operations of DC drives – Inverter based V/f Operation (motoring and braking) of induction motor drive system – Induction motor and permanent motor based vector control operation – Switched reluctance motor (SRM) drives – Vehicle-to-Grid Technology.

Total: 45

REFERENCES:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicle”, CRC Publisher, 2010.
2. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals”, 2nd Edition, CRC Press, Taylor & Francis Group, 2011.
3. Sira-Ramirez, Silva Ortigoza R., “Control Design Techniques in Power Electronics”, Springer, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	explain the need and importance of EV/HEV for sustainable future	Understanding (K2)
CO2:	illustrate the principles of various EV/HEVs drive train topologies	Understanding (K2)
CO3:	apply the various control strategies of series & Parallel HEVs	Applying (K3)
CO4:	analyze and evaluate the various aspects and performance of EV battery technologies	Applying (K3)
CO5:	design and select EV drive for the desirable performance and control	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2		2
CO2	2		2
CO3	3		2
CO4	3	2	1
CO5	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEE13 ENERGY STORAGE SYSTEMS

L	T	P	Credit
3	0	0	3

Preamble	This course is aimed to introduce the fundamental concepts and principles of various energy storage systems that aids in various electrical applications.
Prerequisites	Fundamental Chemistry

UNIT – I **9**

Energy Storage Systems: Introduction - Need of energy storage - Battery - Components of Cells and Batteries – Classification - Operation of a Cell - Theoretical Cell Voltage, Capacity, and Energy - Electrochemical Principles and Reactions: Cell Polarization - Electrical Double-Layer Capacity and Ionic Adsorption - Mass Transport to the Electrode Surface

UNIT – II **9**

Primary and Secondary Batteries: Battery parameters and specification - Performance, charging and discharging- storage density, energy density, classical & Modern batteries: Zinc-chloride – Nickel Cadmium-Lead Acid - Nickel Hydride, Lithium Battery-Principle and working.

UNIT – III **9**

Ultra Capacitors and Fuel Cells: Ultracapacitors: Features- Basic Principles of Ultracapacitors - Performance of Ultracapacitors – Mathematical model, Fuel cells: direct energy conversion - Polarization loss - types of fuel cells -hydrogen oxygen cells, Comparison of fuel cells, Hybridization of Energy Storage systems.

UNIT – IV **9**

Applications of Secondary Batteries: Storage of Solar – generated Electricity – Batteries in Space – Storage in Electric Supply Networks – Electric Vehicles – Role of Ultracapacitors in EVs.

UNIT – V **9**

Other Energy Storage Techniques: General Considerations - Thermal Energy Storage – Flywheel Storage – Pumped Hydro Storage – Compressed Energy Storage – Applications.

Total: 45

REFERENCES:

1. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals”, 2nd Edition, CRC Press, Taylor & Francis Group, 2011.
2. Ali Emadi, Mehrdad Ehsani, John M.Miller, “Vehicular Electric Power Systems”, Special Indian Edition, Marcel dekker, Inc 2010.
3. Tetsuya Osaka and Madhav Datta, “Energy Storage Systems in Electronics”, Gordon and Breach Science Publishers, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	evaluate the various aspects and performance of EV battery technologies	Understanding (K2)
CO2:	conceptualize the principles of Primary and Secondary batteries	Understanding (K2)
CO3:	illustrate the concepts & Principles of ultra capacitors and fuel cells	Understanding (K2)
CO4:	analyze the requirement of secondary batteries in engineering applications	Applying (K3)
CO5:	identify a suitable energy storage technique for the desirable performance	Applying (K3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2		2
CO2	2		2
CO3	2		2
CO4	3	2	1
CO5	3	3	1

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEE14 POWER ELECTRONIC APPLICATIONS IN POWER SYSTEMS

L	T	P	Credit
3	0	0	3

Preamble	This course brings the applications of power electronic applications in power system by incorporating the features of various compensators. In addition, it also provides an insight to harmonics and filters in improving the performance parameters of power system.
Prerequisites	Power Electronics, Power System Analysis and Stability, Power System Protection and Switchgear, Power Quality

UNIT – I **9**

HVDC Transmission: Introduction – Comparison of AC and DC transmission- Application of DC transmission-Description of DC transmission system-Planning for DC transmission- Modem trend in DC transmission-Characteristics of twelve pulse converters- Principle of DC link control - Converter control characteristics – System control hierarchy-Firing angle control-CEA control.

UNIT – II **9**

MTDC Systems and Filtering Approach: Introduction to MTDC –potential applications of MTDC systems-Types of MTDC systems-control and protection of MTDC systems- Smoothening reactor-Transient over voltages in DC line - DC breakers- Monopolar operation - Effects of proximity of DC and AC transmission systems.

UNIT – III **9**

Static Shunt Compensators: Objectives of Shunt Compensation - Methods of Controllable VAR generation - Static VAR Compensators: SVC and STATCOM - Comparison between SVC and STATCOM. **Static Series Compensator:** Objectives of Series Compensation- Variable Impedance Type Series Compensators: GCSC, TSSC, TCSC - Switching Converter Type Series Compensators: SSSC -External Control of Series Reactive Compensators- Characteristics and Features of Series Compensators.

UNIT – IV **9**

Static Voltage and Phase Angle Regulators: Objectives of Voltage and Phase Angle Regulators – Functional Requirements – Thyristor-Controlled Voltage and Phase Angle Regulators (TCVRs and TCPARs) – Switching Converter based Voltage and Phase Angle Regulators- Hybrid Phase Angle Regulators. **Combined Compensators:** Introduction – Unified Power Flow Controller (UPFC) – Operating Principle-Conventional control capabilities-Real and reactive Power Flow Control – Interline Power Flow Controller (IPFC)- Principles and Characteristics – Control Structure- Generalized and Multifunctional FACTS Controllers.

UNIT – V **9**

Harmonics and Filters: Introduction- Generation of harmonics - Design of AC filters - DC filters - carrier frequency and radio interference.

Total: 45

REFERENCES:

1. Narain G. Hingorani and Laszlo Gyugyi, "Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems", Wiley-Technology and Engineering, 2000.
2. Padiyar K.R., "HVDC Power Transmission System", 2nd Edition, New Academic Science Ltd., 2012.
3. Mohan Mathur P., Rajiv K. Varma, "Thyristor-Based Facts Controller for Electrical Transmission System", John Wiley and Sons Inc., IEEE Press, USA, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	explain the concepts of HVDC transmission and converter control characteristics	Understanding (K2)
CO2:	explain the potential applications of MTDC systems and usage of smoothening reactor	Understanding (K2)
CO3:	make use of shunt and series compensators for the performance improvement in power system	Applying (K3)
CO4:	explain the principle and operation of combined compensators and voltage, phase angle regulator	Understanding (K2)
CO5:	demonstrate the filter design for the suppression of harmonics in the power system	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	2		3
CO2	3		3
CO3	3	2	3
CO4	2		3
CO5	3	2	3

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy

18PEE15 INDUSTRIAL DRIVES

L	T	P	Credit
3	0	0	3

Preamble	The objective of the course is to provide knowledge about various control mechanisms employed in industrial drives.
Prerequisites	Power Electronics, Electrical Machines, Solid State DC Drives, Solid State AC Drives

UNIT – I **9**

Basic Requirements of Industrial Applications: Metal Industries, machine tools, material handling including lifts, hoists, fans, blowers and pumps, test rigs for electric generators and motors, food industries - Drive characteristics - Selection of converters and motors for different applications- advantages and limitations - Duty cycles and cyclic duration factor.

UNIT – II **9**

Typical Drive Functions: Speed / frequency reference setting- speed ramps- PI control- V/f Control systems - torque and current control systems – scalar, vector control- self tuning system, protections and trips- drive programming and user defined functionalities- safety aspects and standards for drives.

UNIT – III **9**

Special Techniques used in Modern Drives: Speed reference corresponding to linear motion in paper and metal industries - cascade speed controls - registration system for printing applications - master and helper drives and load sharing - load sharing of motors - speed control and current control - tension control using position transducer - winder control

UNIT – IV **9**

Specific Industry Applications: HVAC system and building automation ; Cranes and hoists ; port and gantry cranes - elevators and lifts - metal forming and rolling applications - sectional paper machine applications including load sharing and surface winding - two and three drum winders for finishing paper reels ,coating, plating and galvanizing lines- extruder drives for plastic industries

UNIT – V **9**

Industry Environment: AC supply - power factor and harmonics- Interaction between drives and motors - Thermal management of motors and drives - Power supply management - EMC - Protection to Drives - Other miscellaneous requirements – vibration, critical speed, safety of Installation.

Total: 45

REFERENCES:

1. Bill Drury, “The Control Techniques Drives and Controls Handbook”, 2nd Edition, Institution of Engineering and Technology, 2009.
2. Werner Leonhard, “Control of Electrical Drives”, Springer, 2006.
3. Shepherd W., Hulley L.N. and Liang D.T.W., “Power Electronics and Motor Control”, 2nd Edition, Cambridge University Press, 1996.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the various requirements of industrial applications	Understanding (K2)
CO2:	identify the various control mechanisms employed in industries	Applying (K3)
CO3:	make use of the advanced techniques used in modern drive applications	Applying (K3)
CO4:	utilize the concepts employed in HVAC systems	Applying (K3)
CO5:	infer the safety related concepts in industries	Understanding (K2)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3
CO1	3		2
CO2	3		2
CO3	3		2
CO4	3		2
CO5	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial, BT - Bloom's Taxonomy