Electrical Engineering

CO of All Semesters

Program Outcomes (POs)

At the end of successul completion of program, the graduates will be able to—

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assesssocietal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

SEMESTER III

Sr. No	Code No.	Subject	Credits
1.	BSC-EE201	ENGINEERING MATHEMATICS-III	5
2.	PCC-EE202	ELECTRICAL ENGINEERING MATERIALS AND ENERGY CONVERSION	3
3.	PCC-EE203	ANALOG ELECTRONICS ENGINEERING	5
4.	PCC-EE204	BASIC CIRCUIT THEORY	6
5.	PCC-EE205	ELECTRICAL MEASUREMENT	5
6.	PCC-EE206	C PROGRAMMING	1
			25

Sr. No	Sem	Code No.	Subject	Credits
1	III	BSC-EE201	ENGINEERING MATHEMATICS-III	5

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) **CO201.1** Make use of Linear Differential Equations to solve the Electrical Engineering problems.
2) **CO201.2** Apply knowledge of vector differentiation to find directional derivatives, curl and divergence of vector fields.
3) **CO201.3** Define fuzzy sets using linguistic words and represent these sets by membership functions, convexity, Normality, support, etc.
4) **CO201.4** Develop Fourier series expansion of a function over the given interval.
5) **CO201.5** Find Laplace transforms of given functions and use it to solve linear differential equations.
6) **CO201.6** Solve basic problems in probability theory, including problems involving the binomial, Poisson, and normal distributions.

Syllabus:

Course	Teaching Scheme					Evaluation Scheme			
						Theory (Marks)		Practical(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing
Engineering Mathematics-III	04	01	-	05	ISE	-	-	25	40%
					MSE	30	40%	-	-
					ESE	70	40%	-	-

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION I

Unit 1: Linear Differential equations with constant coefficients: (8)

Linear Differential equations with constants coefficients and their methods ofsolutions Applications of Linear Differential equations with constants coefficients to electrical engineering problems

Unit 2: Vector differential calculus (6)

Differentiation of vectors Consistency of linear system equations

Gradient of scalar point function and directional derivative

Divergence of vector point function and solenoidal vector fields

Curl of a vector point function and irrotational vector field

U**nit 3: Fourier Series (7)**

Definition, Euler's formulae Expansions' of functions in the interval ((0,2π) Change of interval . Expansion of Even and Odd functions

SECTION II

Unit 4: Laplace Transform (8)

Definition and transforms of elementary functions Properties of Laplace transform Inverse Laplace transform

Unit 5: Applications of Laplace transform: (7)

Laplace Transform of Periodic functions

Laplace Transform of Heaviside's Unit – Step functions

Laplace Transform of Unit Impulse function (Dirac-Delta function)

Solution of Linear Differential equations with constants coefficients

Unit 6: Z-Transform: (6)

Definition, Z-Transform of standard functions

Properties of Z-Transform, Inverse Z- Transform

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should beas perthe university pattern for practical batches.
2. Minimum number of assignments should be 8 covering all topics.

Recommended Books:

1. A text book of Applied Mathematics, Vol.I by P. N. Wartikar& J. N. Wartikar, PuneVidyarthiGrihaPrakashan, Pune.
2. Higher Engineering Mathematics by Dr. B. S. Grewal, Khanna Publishers, Delhi.

Reference Books:

1. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley India Pvt. Ltd.

2. Advanced Engineering Mathematics by H. K. Dass, S. Chand, New Delhi.
3. A text book of Engineering Mathematics Volume I by Peter V. O'Neil and Santosh K. Sengar, Cengage Learning.
4. Mathematical methods of Science and Engineering by Kanti B. Datta, CengageLearning.
5. A text book of Engineering Mathematics by N. P. Bali, Iyengar, Laxmi Publications (P) Ltd., New Delhi.

Sr. No	Sem	Code No.	Subject	Credits
2	III	PCC-EE202	ELECTRICAL ENGINEERING MATERIALS AND ENERGY CONVERSION	3

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) **CO202.1** Understand the types of engineering materials &the principles of Electro-mechanical Energy Conversion
2) **CO202.2** Use materials for energy conversion

Syllabus:

Course	Teaching Scheme					Evaluation Scheme			
						Theory (Marks)		Practical(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for Passing
EEMEC	03	-	-	03	ISE	-	-	25	40%
					MSE	30	40%	-	-
					ESE	70	40%	-	-

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION I

Unit 1: Conductive materials (7)

General properties and specifications of conductor materials, Factors affecting resistivity, Thermal conductivity of metals, Conductor bimetals, Types of fuse, Electrical carbon materials, Superconductivity

Unit 2: Insulating Materials (5)

General properties of insulating materials, Thermal classification,Dielectricgases, Liquid & solid insulating materials, Insulation measurement, Insulating materials for electrical devices

Unit 3:Magnetic Materials **(7)**

Magnetic parameters, Classification of magnetic materials, Ferromagnetic behaviour below critical TemperatureFerromagnetic Materials at high temperature, Weiss theory of ferromagnetism, Magnetic materials for electric devices, Soft magnetic materials, Hard magnetic materials.

SECTION II

Unit 4: Dielectrics: **(5)**

Dielectric parameters and dielectric losses, Different types of dielectric materials and their classification Dielectrics as electric field medium, Dielectric properties ofinsulators in static fields, Mechanism of polarization, ionic polarization, orientational polarization, Internal field in solids and liquids

Unit 5: Principles of Electro-mechanical Energy Conversion: **(7)**

Flow of energy in magnetic systems , Energy in magnetic systems (defining energy & Co-energy)Singly Excited Systems: Static Energization, Dynamic Energization, Instantaneous Movement, Transient Movement, Doubly excited systems, Energy stored in magnetic field , Electromagnetic torque

Unit 6: Materials for direct Energy conversion devices: **(5)**

Solar cells, MHD generation, Fuel cells ,Thermoelectric generator , Thermo ionicconverters

General Instructions:

1. Minimum number of assignments should be 6 covering all topics.

Recommended Books:

1. A course in Electrical Engineering Materials, S.P. Seth, P.V. Gupta, DhanpatRai& Sons.
2. Electrical Engineering Materials, A.J. Dekker, PHI.
3. Electrical Engineering Materials, T.T.T.I, Madras.

Reference Books:

1. Materials Science for Electrical & Electronics Engineers, Ian P. Jones, Oxford
2. Electrical Properties of Materials, L. Solymar& D. Walsh, Oxford
3. Introduction to material science for engineers, J.K. Shackelford &M.K. Muralidhara, Pearson.
4. Electrical Machines,D.P. Kothari and I.J. Nagrath

Sr. No	Sem	Code No.	Subject	Credits
3	III	PCC-EE203	ANALOG ELECTRONICS ENGINEERING	5

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) **C203.1** Understand various semiconductor devices.
2) **C203.2** Describe BJT and JFET operation.
3) **C203.3** Classify feedback amplifiers & analyze various oscillators.
4) **C203.4** List ideal op amp characteristics and explain configuration.
5) **C203.5** Explain op-amp applications.
6) **C203.6** Describe applications of IC 555 timer.

Syllabus:

Course	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for Passing	Max.	Min. for Passing
Analog Electronics Engineering	04	00	01	05	ISE	-	-	25	40%	-	-
					MSE	30	40%	-	-	-	-
					ESE	70	40%	-	-	50	40%

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION I

Unit 1: Applications of semiconductor devices (9)

1. Review of diode
2. Construction, characteristics and applications of special purpose diodes- LED, Photo diode, Zener diode, Tunnel diode, Varactordiode, Schotkky diode
3. Types of rectifiers and its analysis: - Half wave rectifier, center tapped full waverectifier and full wave bridge rectifier.
4. Filters
5. Series and shunt voltage regulators(Numerical on rectifiers expected)

Unit 2: Small Signal Analysis (7)

1. Review of transistors,
2. Load line and operating point of BJT
3. Bias stability
4. Biasing circuits of transistors

5. Thermal runaway and use of heat sink
6. Cascade amplifier
7. Construction and working of JFET and MOSFET

Unit 3: Feedback Amplifiers **(5)**

1. Introduction to positive and negative feedback amplifiers
2. Barkhausen criterion
3. Voltage /current, series / shunt feedback amplifiers,
4. Operation and analysis of oscillators: - RC phase shift, Wien bridge, Hartley, colpittsand crystal oscillators.

SECTION II

Unit 4: Op-amp Fundamentals and its characteristics **(7)**

1. Introduction to op-amp: definition, symbol, block diagram
2. Op-amp characteristics: - ideal and practical
3. Op-amp parameters- Input offset voltage, Input bias current, input offset current,Output offset voltage, CMRR, SVRR etc.
4. DC and AC characteristics-
5. Thermal drift
6. Slew rate and slew rate equation
7. Op-amp configuration: - open loop and closed loop
8. Inverting, non-inverting and differential amplifier, voltage gain derivation (Numerical expected)

Unit 5: Applications of Op-amp **(8)**

1. Summing, scaling and averaging amplifier
2. Instrumentation amplifier
3. Integrator
4. Differentiator
5. Log and antilog amplifiers
6. Peak detector
7. Basic comparator
8. Schmitt trigger
9. Precision rectifiers: - Half wave and Full wave
10. Triangular and Square wave generator

Unit 6: Special IC Applications **(6)**

1. Introduction of timer and its need.
2. IC 555 Timer functional diagram
3. IC 555 as Monostable multi-vibrator and its application
4. IC 555 as Astable multi-vibrator and its application
5. Phase Locked Loops – operating principles, PLL IC 565 and its applications.

Recommended Books:

1. "Electronic Devices and Circuit Theory", Robert L. Boylestad and LouisNashelsky, PHI/Pearson Education. 9th Edition
2. "Op-amps & Linear Integrated Circuits", Ramakant A. Gayakwad, PHIPublication New Delhi, 2013, 4th Edition

Reference Books:

1. "Operational amplifiers and linear ICs", David A Bell, Oxford University Press, 2010
2. "Electronic Devices and circuits" Jacob Millman, Christos C.HalkiascTata McGrawHill, 3rd edition,2013
3. "Principle of Electronics", V.K.Mehata, RohitMehata, S. Chand
4. "Electronic Principles", Albert Malvino and David J Bates, Tata McGraw Hill, 7th edition,2014.
5. "Electronic Devices and circuits", Allen Mottershead, PHI publication,

List of Experiments

Minimum 8 experiments shall be performed from the following list

1. Study of Full Wave Rectifier with and without filter
2. Study of Zener diode as shunt voltage regulator
3. Study of transistorized series voltage regulator
4. Study of frequency response of RC coupled amplifier
5. Study of transistor biasing circuit
6. Study of transistorized oscillator
7. Study of Inverting and Non-inverting amplifier
8. Study of op-amp based adder and subtractor circuits
9. Study of Schmitt trigger circuit
10. Study of integrator circuit
11. Study of differentiator circuit
12. Study of op-amp based oscillator
13. Study of IC 555 as a stable multi-vibrator
14. Study of IC 555 as mono stable multi-vibrator

Sr. No	Sem	Code No.	Subject	Credits
4	III	PCC-EE204	BASIC CIRCUIT THEORY	6

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) **CO204.1** Analyze AC & DC circuits.
2) **CO204.2** Apply Network theorems to solve Problems.
3) **CO204.3** Solve problems on Two Port Network.
4) **CO204.4** Solve problems on Laplace Transformation.

Syllabus:

Course	Teaching Scheme					Evaluation Scheme			
						Theory (Marks)		Practical(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for Passing
BasicCircuit Theory	04	01	01	06	ISE	-	-	50	40%
					MSE	30	40%	-	-
					ESE	70	40%	-	-

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION I

Unit 1: Analysis of D. C. Circuit (8)

Types of Sources, Dependent and Independent Sources, Source transformation, Star/delta Transformation, Ladder Network, Nodal and Mesh Analysis.

Unit 2:Network Theorems (6)

Superposition theorem, Millman's theorem, Norton's theorem, Thevenin's theorem, Maximum power transfer theorem, Reciprocity theorem, compensation theorem, Tellegen's Theorem

Unit 3:First order and Second Order Circuit (10)

Source free R-C Circuit, Source free R-L Circuit, Step Response of R-C Circuit, Step Response of R-L Circuit, Transient analysis. Initial condition of switched circuits,, unit step, ramp and impulse function. Response of R-C, R-L series circuit to these signals. Second order circuits: Source free Series RLC circuit, Step response of series R-L-C Circuit, General second order circuits.

SECTION II

Unit 4: Sinusoidal Steady State Analysis (08) Sinusoidal steady state analysis: Properties of sinusoidal functions, Phasor, Impedanceand admittance, Series and parallel resonance, Q factor, Selectivity and band width,

A.C. network solution using Norton's theorem, Thevenin's theorem, Superpositiontheorem

Unit 5: Two Port Network(8)

Single port and two port networks, Driving point function, Transfer function of two port network. Z parameters, Y parameters, Hybrid parameters, ABCD parameters, Inter relation between parameters, parameters of interconnected two port networks

Unit 6: .Network Solution using Laplace transform(8)

Introduction to Laplace transform, Properties of Laplace transforms, impulse function, application to solution of differential equation describing volatage-current relationship for circuit in time domain, transformed circuit, transfer function, Determination of Initial Conditions.

General Instructions:

1. Minimum number of assignments should be 6 covering all topics.

Recommended Books:

1. C. K. Alexander, M. N. O. Sadiku: Electrical Circuits, Second Edition Tata McGraw-Hill References.
2. Van Valkenburg: Network Analysis, Third Edition, PHI publication

Reference Books:

1. L.P. Huelsman, Basic circuit theory, Third edition, PHI Publication.2. ElectricalProperties of Materials, L. Solymar& D. Walsh, Oxford
2. William H. Hayt, Jack E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill international, fifth edition

Sr. No	Sem	Code No.	Subject	Credits
5	III	PCC-EE205	ELECTRICAL MEASUREMENT	5

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

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

1) **C205.1** Explain the various concepts of measuring instruments & types of secondary instruments.
2) **C205.2** Analyze different methods for measurement of resistance, inductance, capacitance, power, energy and measurement of current & voltage using CT & PT.
3) **C205.3** Compute inductance measurement by Maxwell bridge & power measurement by different wattmeter methods.
4) **C205.4** Compare types of transducers & displacement measurement techniques.

Syllabus:

Course	TEACHING SCHEME					EVALUATION SCHEME					
						Theory (Marks)		Practical(Marks)			
								TW		POE	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for Passing	Max.	Min. for Passing
Electrical Measurement	04	-	01	05	ISE	-	-	25	40%	-	-
					MSE	30	40%	-	-	-	-
					ESE	70	40%	-	-	50	40%

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION I

Unit 1: Principle of Measuring Instruments (8Hrs)

Types of Error in Measurement, Absolute and secondary instruments, Types of Secondary Instruments: Indicating, Integrating Instruments Difference between Indicating and Integrating Instruments. Construction, working principle, torque equation, advantages and disadvantages of Moving Iron (MI) (attraction andrepulsion), Permanent Magnet Moving Coil (PMMC) & Dynamometer type instruments. Shunts, multipliers (Numerical Expected)

Unit 2: Measurement of Resistance, Inductance & Capacitance (9Hrs)

Measurement of low, medium and .high resistance Wheatstone bridge, Kelvin's double bridge, ammeter-voltmeter method, Megger, Earth tester for earth resistance measurement .Maxwell's Inductance bridge, Maxwell's Inductance & Capacitance Bridge, Hay's bridge, Anderson's bridge, Campbell's Bridge , Owen's bridge, Schering Bridge (Numerical on Maxwell Bridge)

Unit 3: Measurement of Power (6Hrs)

Power & Its types (Active, Reactive & Apparent Power), Power in DC & AC Circuits, Power factor. Construction, working principle, torque equation, errors and their compensation, advantages and disadvantages of dynamometer type wattmeter, low power factor wattmeter, poly-phase wattmeter. Active & reactive power measurement in three phase system for balanced and unbalanced load using three wattmeter method, two wattmeter method & one wattmeter method.

SECTION II

Unit 4: Measurement of Energy (6 Hrs)

Energy meter- Construction, working principle, torque equation, errors and adjustments of single phase conventional (induction type) energy meter, Calibration of energy meter. Digital Energy Meter, Block diagram and operation of electronic energy meter. Three phase energy meters. Testing of energy Meters.

Unit 5: Transducers & Displacement Measurement (9 Hrs)

Construction and working principle of CRO& DSO,advantages and disadvantages of DSO over CRO.

Transducers: Introduction, classification, basic requirements for transducers. Selection of Transducer, Electrical transducer, Resistive transducer, Resistive position transducer, Resistance thermometer, inductive transducer, Pressure inductive transducer, capacitive transducer(pressure), High pressure measurement using electric methods,Piezzo- electric & photo electric transducer, temperature transducers.

Displacement Measurement- LVDT&RVDT construction, working, application, advantages, disadvantages.

Unit 6: Recent Development in Measurements (4 Hrs)

WaveAnalysers& Harmonic Distortion, Power Analyser, Computer aidedmeasurements, Instrument Transformers: Construction, connection of CT & PT in the circuit.

Recommended Books:

Sr. No.	Title	Author	Publisher	Edition	Year

1	Electronic Measurements & Instrumentation	A. K. Sawhney	DhanpatRai& Co.	9th	2014
2	Electrical Measurements& Instrumentation	J. B. Gupta,		8th	2012

Reference Books:

Sr. No.	Title	Author	Publisher	Edition	Year
1	Electrical Measurements & Measuring Instruments	E. W. Golding F. C. Widdies	Reem Publications	rd 3	2011
2	Electrical Measurement & Instrumentation	Sirohi Radhakrisnan	New Age International	3rd	2010

List of Experiments:

The term work shall consist of any 8 experiments(excluding study experiments) from listgivenbelow:

1. Demonstration of various analog measuring instruments
2. Measurement of Active & reactive power in three phase circuit using two wattmetermethod
3. Calibration of Single phase Induction type energy meter at different power factors
4. Measurement of resistance by ammeter voltmeter method.
5. Measurement of resistance using Whetstone's/Kelvin's bridge.
6. Measurement of inductance using Maxwell's/Hay's/Anderson's bridge.
7. Measurement of capacitance using Schering's bridge
8. Measurement of earth resistance using earth tester.
9. Displacement measurement by LVDT.
10. Study of Digital Meters and Oscilloscopes.
11. Study of Power Analysers.
12. Study of C.T. and P.T.

SEMESTER IV

Sr. No	Code No.	Subject	Credits
1.	PCC-EE211	D.C. MACHINES AND TRANSFORMER	5
2.	PCC-EE212	POWER ELECTRONICS	4
3.	PCC-EE213	POWER SYSTEM-I	5
4.	PCC-EE214	ELECTROMAGNETIC	4
5.	PCC-EE215	CONTROL SYSTEM-I	4
6.	PCC-EE216	ENVIRONMENTAL STUDIES	3
		Total=	**25**

Sr. No	Sem	Code No.	Subject	Credits
1	IV	PCC-EE211	D.C. MACHINES AND TRANSFORMER	5

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

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

1) **CO211.1** Explain Concepts of DC Machine, DC Motors, Single phase & Poly phase transformer
2) **CO211.2** Analyze the different parameter by testing the DC machines
3) **CO211.3** Examine the concept Universal motors & circle diagram in universal Motor.
4) **CO211.4** Evaluate the performance of three phase transformer.

Syllabus:

Course	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for Passing	Max.	Min. forPassing
DCMT	04	00	01	05	ISE	-	-	25	40%	-	-
					MSE	30	40%	-	-	-	-
					ESE	70	40%	-	-	50	40%

SECTION I

Unit 1: DC Machines: **(8)**

Constructional Details:,power flow diagram of D.C. machines. Construction of D.C. machines, magnetic circuit of DC machines, commentator and brush arrangement, EMF equation, torque equation

Armature Winding: Simple lap winding and wave winding, winding diagram and tables, brush position, dummy coils.

Armature Reaction: MMF due to armature winding, flux distribution due to armature current and resultant flux distribution in a machine. Demagnetization and cross magnetization ampere turns, principle of compensation, compensating winding and its use in machines.

Unit 2: D.C. Motors: **(7)**

Concept of back e.m.f., characteristics of D.C. motors, Method of speed controls, electro braking, parallel and series operation of motor. Testing of D.C. Machines:

Losses and efficiency, Break test, Swinburn's test, Hopkinson's test, Retardation test, Field test on D.C. series motor. Applications of DC Machines

Unit3 : Universal Motor: **(6)**

Development of torque & power, rotational and transformer emf in commutator winding, commutation in universal motor, complex or diagram, circle diagram, operation on A.C. and D.C. supply, compensated winding, applications.

SECTION II

Unit 4: **Single Phase Transformer:** **(7)**

Construction and type, EMF equation phasor diagram, equivalent circuit, efficiency, losses, regulation, Experimental determination of equivalent circuit parameters and calculation of efficiency and regulation, parallel operation.

Unit 5: Poly Phase Transformer: **(7)**

Construction, single phase bank, polarity test, transformer winding, Grouping YD1, YD11, DY1, DY11, DZ1, DZ11,YZ1, YZ11, Parallel operation of Dy1 and Dy11.

Unit 6: Performance of Three Phase Transformers: **(7)**

Switching inrush current, Harmonics in exciting current causes and effects, Harmonics with different transformer connections, tertiary winding, oscillating neutral, Testing of transformers as per IS2026 , heat run test, Sumpner's test, Equivalent delta test.

Text Books:

1. S. J. Chapman, "Electrical Machines", McGraw Hill publication, 3rd Edition.
2. M. G. Say. "Performance Design of AC Machines".
3. O. E. Taylor, "Performance Design of AC commutator motors".

References Books :

1. SK Bhattacharya, "Electrical Machines", Tata McGraw Hill, New Delhi.
2. J. B. Gupta, "Electrical Machines", SK Kataria and Sons, New Delhi.
3. Fitzerald and Kingsley,"Electric Machine", Tata McGraw Hill.

Sr. No	Sem	Code No.	Subject	Credits
2	IV	PCC-EE212	POWER ELECTRONICS	4

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

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

1) **CO212.1** Explain principle of power semiconductor devices and of rectifiers, power converters, inverters
2) **CO212.2** Utilize various power devices into different power converter circuits
3) **CO212.3** Analyze the behavior of converters, rectifiers and inverters by observing their waveforms
4) **CO212.4** Evaluate the performance of various power devices, power converters and rectifiers with their performance parameters
5) **CO212.4** Design circuits for particular application

Syllabus:

Course	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for Passing	Max.	Min. for Passing
Power Electronics	03	-	01	04	ISE	-	-	25	40%	-	-
					MSE	30	40%	-	-	-	-
					ESE	70	40%	-	-	50	40%

SECTION I

Unit 1: Power Semiconductor Switches (6)

Characteristics of an ideal switch. Characteristics, Rating, protection and cooling of power semiconductor devices such as power diodes, transistor, MOSFET, IGBT and GTO, Study of the driver circuits for thyristor, GTO and IGBT, Introduction to smart power modules, Comparative study of MOSFET, thyristor, GTO, BJT and IGBT.

Unit 2: Single phase and three phase Rectifiers (5)

Single phase half wave and single phase full wave diode bridge. Three phase half wave and three phase full wave diode bridge, Transformer power rating for above configurations waveforms of source current , DC current and output DC voltage waveforms .

Unit 3 :Phase Controlled AC to DC Converters: (10)

Classification of converters, Single phase half controlled and fully controlled thyristor converters, Three pulse and six pulse controlled converters, operation of converter with freewheeling diode. Effect of source inductance on the performance of the converter,

overlap – angle. Performance factors for the converter such as displacement factor,distortion factor, total harmonic distortion, ripple factor and transformer utilization factor. Introduction to 12 pulse converter, single phase and three phase dual converter, firing scheme for 1 phase and three phase converter.

SECTION II

Unit 4: DC to DC Converters (7)

Control of DC to DC converters, step down (buck) converter, Analysis of buck converter with RLE load, step up converter, buck – boost converter, full bridge DC to DC converter, concept of multiphase choppers, cuk converter.

Unit 5: Switch Mode DC – AC Inverters (8)

Basic concepts of switch mode inverters, single phase half bridge and full bridge inverter, three phase six step inverter, 1200 mode of conduction, 180 degree mode of conduction, three phase PWM Inverter, sinusoidal PWM and selective harmonics elimination methods of PWM. Voltage and frequency control, Effect of blanking time on output voltage in PWM inverters. Applications of three phase and single phase inverters

Unit 6: Cyclo- converters and Matrix Converter (6)

Introduction to Single phase and three phase cyclo-converters. Working and topologiesof Matrix converter, control methods, performance analysis of matrix converter. Applications ofCyclo- converters and Matrix Converter

Text Books:

1. H. Rashid “Power Electronics, Circuits, Devices and Applications”, Pearson Education Inc., 3rd Edition.
2. P. S. Bhimra, “Power Electronics”, 2nd edition, Khanna Publishers

References Books:

1. B.K. Bose, “Modern Power Electronics and A.C. Drives”, Prentice Hall of India Pvt. Ltd. Publication.
2. Ned Mohan, Undeland and Robins, “Power Electronics, Converter Applications and Design”, John Wiley and sons (Asia) Pvt. Ltd.
3. G. K. Dubey and Others “Thyristorised Power Controller”, Wiley Eastern Ltd.

Sr. No	Sem	Code No.	Subject	Credits
3	IV	PCC-EE213	POWER SYSTEM-I	5

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) **CO213.1** Explain the Electric Supply System
2) **CO213.2** Design the Electrical & Mechanical Design of Overhead Lines
3) **CO213.3** Discuss the Performance of Transmission Line
4) **CO213.4** Explain the construction & Classification of Underground Cable
5) **CO213.5** Solve the problems of Voltage drop calculations in radial & ring main

Syllabus:

Course	Teaching Scheme					Evaluation Scheme			
						Theory (Marks)		Practical(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for Passing
Power System I	04	-	01	05	ISE	-	-	-	-
					MSE	30	40%	-	-
					ESE	70	40%	50	20

1. Supply System

Electric Supply System, Typical A.C. Power Supply Scheme, Comparison of D.C. and A.C. Transmission—Advantages of High Transmission Voltage—Various Systems of Power Transmission— Comparison of Conductor Material in Overhead System—Comparison of Conductor Material in Underground System—Comparison of Various Systems of Transmission—Elements of a Transmission Line—Economics of Power Transmission—Economic Choice of Conductor Size—Economic Choice of Transmission Voltage—Requirements of satisfactory electric supply.

2. Electrical Design of overhead lines

Constants of a Transmission Line—Resistance of a Transmission Line—Skin effect— Flux Linkages—Inductance of a Single Phase Overhead Line—Inductance of a 3-Phase Overhead Line—Concept of self-GMD and mutual GMD—Inductance Formulas in terms of GMD—Electric Potential—Capacitance of a Single Phase Overhead Line— Capacitance of a 3-

Phase overhead Line.

3. Mechanical Design of Overhead Lines.

Main components of Overhead Lines—Conductor Materials—Line Supports— Insulators—Type of Insulators—Potential Distribution over Suspension Insulator String—String Efficiency—Methods of Improving String Efficiency—Important Points—Corona—Factors affecting Corona—Important Terms—Advantages and Disadvantages of Corona—Methods of Reducing Corona Effect—Sag in Overhead Lines—Calculation of Sag—Some Mechanical principles.

4. Performance of Transmission Line.

Classification of overhead Transmission Lines—Important Terms—Performance of Single Phase Short Transmission Lines—Three-Phase Short Transmission Lines— Effect of load p.f.on Regulation and Efficiency—Medium Transmission Lines—End Condenser Method—Nominal T Method—Nominal π Method— Long Transmission Lines—Analysis of Long Transmission Line—Generalised Constants of a Transmission Line— Determination of Generalised Constants for Transmission Lines.

5. Underground Cables

Construction of Cables—Insulating Materials for Cables—classification of Cables— Cables for 3-Phase Service—Laying of Underground Cables—Insulation Core Cable— Dielectric Stress in a Single Core Cable—Most Economical Conductor Size in a Cable—Grading of Cables—Capacitance Grading—Intersheath Grading—Capacitance of 3-Core Cables—Measurement of Cc and Ce—Current carrying capacity of underground cables—Thermal resistance—Thermal resistance of dielectric of single- core cable—Permissible current loading—Types of cable faults—Loop tests forlocation of faults in underground cables.

6. Distribution System General

Distribution systems – classification and arrangement of distribution systems –Voltage dropcalculations in radial and ring mains – comparison of different systems - DC, AC - single phase,three phase 3 wire - 4 wire systems

TEXT AND REFERENCE BOOKS:

1. C. L. Wadhawa , “Electrical Power System”, John Wiley & Sons.
2. HadiSaadat, “ Power System Analysis”, Tata McGraw-Hill.
3. I.J. Nagrath&D.P.Kothari, “Modern Power System Analysis”, Tata McGraw-Hill.
4. W.D. Stevenson and J.J. Grainger, “Power System Analysis”, McGraw-Hill.
5. W.D. Stevenson, “Elements of Power System Analysis”, McGraw-Hill.

Sr. No	Sem	Code No.	Subject	Credits
4	IV	PCC-EE214	ELECTROMAGNETIC	4

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) **CO214.1** Student should able to create differentiates different types of co-ordinate systems and solving the problem of electromagnetic field theory.
2) **CO214.2** Student should able to evaluate static electric and magnetic fields, their different media, associated laws, boundary conditions and electromagnetic potentials.
3) **CO214.3** Student should able to analyze integral and point form of electric and magnetic fields, for solving the problems of electromagnetic field theory.
4) **CO214.4** Student should able to apply problems of electric field theory and magnetic field theory.
5) **CO214.5** Student should able to understand electric field theory and magnetic field theory, electromagnetic waves in different media.
6) **CO214.6** Student should able to remember co-ordinate systems, electric and magnetic fields, time varying fields, Maxwell's equations electromagnetic waves in different media.

Syllabus:

Course	Teaching Scheme					Evaluation Scheme			
						Theory (Marks)		Practical(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for Passing
Electromagnetic	03	01	-	04	ISE	-	-	-	-
					MSE	30	40%	-	-
					ESE	70	40%	-	-

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION I

UNIT 1: Vector Analysis: (06 Hrs)

Introduction, Coordinate systems and Transformations, Line, surface and volume integrals, Vector calculus, concept of gradient, divergence and curl

UNIT 2: Electrostatics: (10 Hrs)

Coulomb's law, Electric field intensity due to point Charge, line charge, surface charge and volume charge distribution, Electric flux density, Gauss's law and Divergence theorem, Energy, potential energy and work done, potential gradient, dipole and its electric field, dipole movement, energy density in electrostatic field

UNIT 3: Conductor, Dielectrics and Capacitance: (8 Hrs)

Current and current density, Continuity equation of current, properties of conductors, boundary conditions, Energy stored in capacitors, Poisson's and Laplace's equations,

Capacitance between parallel plates and co-axial cable using Laplace's equation

SECTION II

UNIT 4: Steady Magnetic Field: (10Hrs)

BiotSavert's law, Magnetic field due to infinitely long current carrying conductor, Magnetic Field due to infinite sheet of charge, Ampere's circuital law, Application to co-axial cable. Curl operator, Magnetic flux density, Stoke's theorem. Scalar and vector magnetic potential, Lorentz's force equation. Energy stored in magnetic field, boundary conditions

1. Time varying fields and Maxwell's Equations: (06 Hrs)

Faraday's law, General case of Induction, Displacement Current, Modified Amper's Law, Maxwell's equations (Differential, Integral, Phasor forms),

Unit 6: .Electromagnetic Waves (8)

Uniform plane wave, wave equation for free space, wave equation for lossymedia, wave propagation in good conductor and good dielectric, Pointing vector and power flow, Skin effect,

General Instructions:

1. Minimum number of assignments should be 6 covering all topics.

Recommended Books:

1. Engineering Electromagnetic, W. Hayt, Tatat McGraw Hill (7th Edition)
2. Electromagnetic field theory fundamental, Guru and Hizirogli,, Thomson Publication
3. Electromagnetic, J.D. Kraus, McGraw Hill, 4th Edition

Reference Books:

1. Antenna and Wave Propagation, K .D. Prasad, SatyaPrakashan
2. Electromagnetic Engineering, Ryder

Sr. No	Sem	Code No.	Subject	Credits
5	IV	PCC-EE215	CONTROL SYSTEM-I	4

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) **CO215.1** Express classification of control system along with block diagram representation.
2) **CO215.2** Analyze response of first and second order systems, Root locus, Bode Plot
3) **CO215.3** Select the mode of controller according to the types of the system.
4) **CO215.4** Develop the state model of different transfer function.

Syllabus:

Course	Teaching Scheme					Evaluation Scheme			
						Theory (Marks)		Practical(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for Passing
Control System -I	03	-	01	04	ISE	-	-	50	40%
					MSE	30	40%	-	-
					ESE	70	40%	-	-

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

Unit I

Introduction Need & classification of control system, Effects of feedback, Mathematical models – (Mechanical & Electrical systems) Differential equations, Transfer function – Armature & field control of DC servo motor, Block diagram algebra – Block diagram reduction, Representation by Signal flow graph – Reduction using Mason's gain Formula.

Unit II

Time Response Analysis Standard test signals – Time response of first& second order systems –Design specifications of 2nd order system & error compensation, Characteristic Equation of Feedback control systems, Transient response of second order systems – Time domain specifications, Steady state response – Steady state errors and error constants.

Unit III

Stability Analysis In S-Domain The concept of stability – Routh's stability criterion – qualitative stability and conditional stability – limitations of Routh's stability. Root Locus Technique: The root locus concept – construction of root loci-effects of adding poles and zeros to G(s) H(s) on the root locus.

Unit IV

Frequency Response Analysis Introduction, Frequency domain specifications-Bode plots, Determination of Frequency domain specifications and transfer function from the Bode Plot – Phase margin and Gain margin-Stability Analysis from Bode Plots, Polar Plots, Nyquist Stability Criterion, Nyquist plot & stability analysis.

Unit V

Classical Control Design Techniques Compensation techniques –Lag, Lead, Lead-Lag Controllers design in frequency Domain, Design of PID control system.

Unit VI

State Variable Analysis and Design Concept of state, state variable & state model, state model for linear continuous time systems, state variable & linear discrete time system.

General Instructions:

Term Work: Minimum 04 experiments and 04 assignment on MATLAB based on above syllabus should be performed.

Reference Books:

1. Control System Engineering, Norman S. Nise, 4th Edition, John Wiley and Sons, 2004
2. Control Systems Engineering, I.J. Nagrath and M. Gopal, 5th Edition, Anshan Publishers, 2008
3. Feedback Control Dynamic system, Franklin Powel 5th Edition Pearson Education, 2002
4. Modern Control system, Dorf and Bishop, 8th Edition Adison Wesley Longman 1998
5. Modern Control Engineering, Eastern Economy, K. Ogata, 4th Edition, 2002
6. Control System Principles and Design, M. Gopal, Tata McGraw Hill 3rd Edition, 2008.

Sr. No	Sem	Code No.	Subject	Credits
6	IV	PCC-EE216	ENV	

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

1) CO216.1 To study about environment and ecosystems.
2) CO216.1 To study about different types of natural resource.
3) CO216.1 Knowledge and concept of biodiversity and its conservation.
4) CO216.1 Basic knowledge and concept of causes, effect and control of different type of environmental pollution.
5) CO216.1 To study population growth and its impact on environment.

Syllabus:

Course	Teaching Scheme					Evaluation Scheme			
	L	T	P	Credit	Scheme	Theory (Marks)		Practical(Marks)	
						Max.	Min. for Passing	Max.	Min. for Passing
Environmentalstudies	03	-	-	03	ISE	-	-	-	-
					MSE	30	40%	-	-
					ESE	70	40%		

Unit1. Nature of Environmental Studies: (2 lectures)

Definition, scope and importance. Multidisciplinary nature of environmental studies. Need for public awareness.

Unit2. Natural Resources and Associated Problems: (8 lectures)

a) Forest resources: Use and over-exploitation, deforestation, dams and their effects on forests and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Usage and exploitation. Environmental effects of extracting and using mineral resources. d) Food resources: World food problem, changes caused by agriculture effect of modern agriculture, fertilizer-pesticide problems. e) Energy resources: Growing energy needs, renewable and non- renewable energy resources, use of alternate energy sources. Solar energy , Biomass energy, Nuclear energy. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individuals in conservation of natural resources.

Unit3. Ecosystems : (8 lectures)

Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers.

Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids.

Introduction, types, characteristics features, structure and function of the following ecosystem :-

a) Forest ecosystem, b) Grassland ecosystem, c) Desert ecosystem, d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit4. Biodiversity and its conservation : (8 lectures)

Introduction- Definition: genetic, species and ecosystem diversity. Bio-geographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. India as a mega- diversity nation. Western Ghat as a biodiversity region. Hot-spots of biodiversity. Threats to biodiversity habitat loss, poaching of wildlife, man- wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit5. Environmental Pollution : (8 lectures)

Definition: Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of a individual in prevention of pollution.

Unit6. Social Issues and the Environment : (8 lectures)

Disaster management: floods, earthquake, cyclone, tsunami and landslides Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and

rehabilitation of people; its problems and concerns. Environmental ethics: Issue and possible solutions. Global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products.

Unit7. Environmental Protection : (8 lectures)

From Unsustainable to Sustainable development Environmental Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act Wildlife Protection Act Forest Conservation Act

Population Growth and Human Health, Human Rights.

Unit8. Field Work : (10 lectures)

Visit to a local area to document environmental assets - River/forest/grassland/hill/mountain.

or

Visit to a local polluted site – Urban/Rural/Industrial/Agricultural

or

Study of common plants, insects, birds.

or

Study of simple ecosystems - ponds, river, hill slopes, etc.

(Field work is equal to 10 lecture hours)

SEMESTER V

Sr. No	Code No.	Subject	Credits
1.	PCC-EE301	Digital Electronics And Micro Processor	4
2.	OCE-EE302	Open Elective – I	3
3.	PCC-EE303	AC Machines	4
4.	PCC-EE304	Power System-II	4
5.	PCC-EE305	Advanced Control System	4
6.	PCC-EE306	Signals & Systems	4
7.	PCC-EE307	MATLAB	2
		Total	25

Sr. No	Sem	Code No.	Subject	Credits
1	V	PCC-EE301	Digital Electronics And Micro Processor	4

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) C301.1 Understand basic math operations, Number systems, Logic gates, theorems, properties of Boolean algebra.
2) C301.2 Solve 2, 3 and 4 variable K-map reductions.
3) C301.3 Analyze different types of Adders, Sub tractors, Flip-flops and counters.
4) C301.4 Differentiate various Addressing modes and Instructions.
5) C301.5 Analyze different instructions to assemble application programs.
6) C301.6 Design & Analyze different types of interfacing techniques.

Syllabus:

Course Code And Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE-301 **Digital Electronics AndMicrocontroller**	03	--	02	04	ISE	-	-	25	10	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	-	-	50	20

ISE: InSemesterEvaluation MSE: MidSemesterEvaluation ESE: End Semester Evaluation

SECTION I

Unit 1: Boolean algebra & logic [08]

Number Systems - Binary, Octal, Hexadecimal.Introduction to Logic Gates, Laws, De Morgan's Theorem and Rules of Boolean algebra.Boolean Functions. M – Notations, Equation Simplification using Reduction Techniques.

Unit 2: Simplification of Boolean functions [05]

K – Maps, 2, 3 and 4 Variable Maps. Sum of Products and Product of Sums, Don't CareConditions, NAND-NAND and NOR-NOR Implementation

Unit 3: Combinational logic & Sequential logic [12]

Introduction, Binary Adders &Binary Substractors, Binary to Gray, BCD to Binary, BCDto Excess-3 and Vice Versa, Binary Parallel Adder, Decimal/BCD Adder, Comparators, Decoders, Encoders, Multiplexers, Demultiplexers, Seven Segment Display using 7446/7447,Flip Flops, Shift Registers, Various Counters, Moore Model and MealyModel.

SECTION II

Unit 4: 8051 Architecture and Instructions [10]

Architecture – Microprocessor and Microcontroller, Difference between Microcontrollerand Microprocessor, Microcontroller - Features, Pins and Signals, Program and Data Memory Organization, System Clock. Special Function Registers, Program Status Word, Registers, I/O Ports and Addressing Modes. Data Transfer Instructions .Interrupts, Timer/Counter, Serial Communication. Introduction, Architecture and Block Diagram of PIC Microcontroller.

Unit 5: Assembly Programming Examples [07]

Copy Block, Shift Block, Count no. of Nulls, Find Checksum, Sum of Natural Numbers, Sum of a Series, Fibonacci Series, Generate a Series. Count 1s in a Byte, Find Largest/ Smallest Integers of an Array. Bubble Sorting, Find Sum of Factorials. Compare with External Array, Reverse an Array. Sum of a Series, Generate Prime Numbers.

Unit 6: Interfacing **[06]**

Keyboard, External Memory, Display Devices, DC Motor, Stepper Motor, Servomotor DAC/ADC Interfacing.

List of Experiments:

Minimum five experiments based on Hardware and five experiments based on Simulations and at least three experiments based on Interfacing.

Recommended Books:

1. Logic Design, A. P. Godse & D. A. Godse, Technical Publications, Pune
2. Digital Logic and Computer Design, Morris Mano, PHI publications
3. Modern digital electronics, R.P. Jain, TMH Publications
4. Fundamentals of digital circuits, Anand Kumar, PHI
5. The 8051 Microcontroller and embedded systems, Muhammad Ali Mazidi, Pearson Education.

Reference Books:

1. Digital Electronics: Principles & Integrated Circuits, A. K. Maini, Wiley Publications
2. Digital Systems- Principles and Design, Rajkamal, Pearson Education
3. The 8051 Microcontroller Architecture, Programming and Applications, Kenneth Ayala,Penram International, 2nd Edition
4. 8051 Microcontroller: Internals, Instructions, Programming and Interfacing,Subrata Ghoshal, Peasrson Publications

Sr. No	Sem	Code No.	Subject	Credits
2	V	OCE-EE302	DOMESTIC /INDUSTRIAL ELECTRICAL INSTALLATION, ESTIMATION AND COSTING Open Elective – I	3

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.

2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

1) **CO302.1** Explain concept of domestic and industrial wiring Estimating, concepts of contracting and Estimating, Costing of Service Connection.
2) **CO302.2** Analyze Estimating and Costing of Domestic and Industrial Wiring.
3) **CO302.3** Design Estimation of Transmission line overhead and underground distribution System.

Syllabus:

Course Code and Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical (Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
OCE-EE-302 **Domestic /Industrial Electrical Installation, Estimation and Costing**	03	--	02	04	ISE	-	-	-	-	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	25	10	--	-

ISE: InSemesterEvaluation MSE: MidSemesterEvaluation ESE: End Semester Evaluation

SECTION I

Unit 1: Electrical Wiring **(6)**

Different types of wires, wiring system and wiring methods,Comparison of different types of wiring, Specifications of Different types of wiring materials, Accessories Different types of wiring tools.Domestic and industrial panel wiring, different types of wiring circuits, I.E. rules for wiring, Electricity supplyact-1948

Unit 2: Elements of Estimating and concepts of contracting **(6)**

Introduction to estimation & estimation tools, Electrical Schedule of rates, catalogues, Survey and source selection, recording estimates. Determination of required quantity of material, Labor conditions, Determination of cost material and labor,Contingencies, Overhead charges, Profit, Purchase system, Purchase enquiry and selection of appropriate purchase mode, Comparative statement, Purchase orders, Payment of bills,Terms, conditions types of contract system. Tendering procedure and preparation of simple tender, Procedure for inviting and scrutinizing tender, Importance of Earnest Money Deposit, Security Deposit and S.O.R. Indian Electricity Act and major applicable I.Erules.

Unit 3: Estimating And Costing of Domestic And Industrial Wiring **(8)**

Principles of circuit design in lighting and power circuits, Procedures for designing the circuits and deciding the number of circuits, Method of drawing single line diagram, Selection of type of wiring and rating of wires and cables, Load calculations and selection of size of conductor, Selection of rating of main switch, distribution board, protective switchgear ELCB and MCB and wiring accessories, Earthing of residential Installation, Sequence to be followed for preparing estimate, Preparation of detailed estimates and costing

of residential installation, Important considerations regarding motor installation wiring, Determination of input power, input current to motors, rating of cables, rating of fuse, size of Conduit, size of distribution Board, main switch and starter. Preparation of detailed estimates and costing industrial installation, I.E. rules observed for above wiring.

SECTION II

Unit 4: Estimating and Costing of Service Connection (Domestic and Industrial): (7)

Concept of service connection, Types of service connection and their features, Method of installation of service connection(1-phase and 3-phase), Lay out/ wiring diagram of service connection list of materials and accessories along with specifications required for given installation work, Estimation of service connection for domestic and industrial (1-phase and 3-phase) I.E. rules pertaining to above wiring.

Unit 5: Estimation of Transmission line: (5)

Main components of overhead lines, Line supports, Factors governing height of pole, Conductor materials, Determination of size of conductor for overhead Transmission line, Cross arms, Pole brackets and clamps, Guys and Stays, Conductors configuration spacing and clearances, Span lengths, Overhead line insulators, Insulator materials Lightning Arrestors, Points to be considered at the time of erection of overhead lines, Erection of supports, Setting of stays, Earthing of lines, Guarding of overhead lines, Clearances of conductor from ground, Spacing between supports conductors, important specifications and sketches List of materials and accessories required for the given project estimate for material required I.E. rules pertaining to above project.

Unit 6: Estimation of Overhead and Underground Distribution System (4)

Survey work for estimation of overhead and underground distribution system. Planning and layout of project. List of materials and accessories required for the given project. Procedure for preparing estimate for 440 V, 3-phase, 4 wire or 3 wire overhead and underground distribution system. Necessary drawing/sketches of overhead and underground system. I.E. rules pertainingto above project.

Term work:

Minimum 6 number of assignments should be covering all topics

1. Draw different types of wiring circuits

2. Prepare a tender for installation of distribution transformer and give procedure for inviting andscrutinizing tender
3. Prepare detailed estimates and costing of residential installation & draw layout of it
4. Draw wiring diagram of domestic and industrial service connection (1-phase and 3-phase)
5. Sketches List of materials and accessories required for installation of Transmission line
6. Prepare estimation of 440V, 3-phase, 4 wire or 3 wire overhead and underground distributionsystem & draw layout of it

Recommended Books:

1. **A course in Electrical Installation, Estimating andcosting, JBGupta, S K Kataria and Sons.**
2. **Electrical InstallationandEstimating, SurjitSingh, Dhanpatrai AndSons.**

Reference Books:

1. **Electrical Design Estimating and Costing K. B. Raina, New Age International, 2007**

Sr. No	Sem	Code No.	Subject	Credits
3	V	PCC-EE303	AC Machines	4

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

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

1) CO303.1 Describe the various concepts of single phase induction motor, three phase induction motor, three phase alternator, synchronous motor.
2) CO303.2 Analyze the performance of single phase, three phase induction motor & three phase alternator.
3) CO303.3 Explain the various special purpose motors.

Syllabus:

Course Code And Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min.for Passing	Max.	Min.for Passing	Max.	Min.for Passing
PCC-EE-303 AC Machines	03	-	02	04	ISE	-	-	-	-	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	25	10	50	20

ISE: InSemesterEvaluation MSE: MidSemesterEvaluation ESE: End SemesterEvaluation

SECTION I

Unit 1: Introduction of Three phase Induction Motor (09)

Construction & types of 3 ph. Induction motors, Rotor quantities (emf ,current, frequency, p.f), torque equation, starting torque, running torque (numerical treatment) , Factors affecting torque, condition of maximum torque ,torque slip characteristics, Need of starters for 3 phase. Induction motors, types of starters (DOL, autotransformer, star-delta, rotor resistance starter, Speed control methods from stator side (Stator voltage control Stator Frequency control, Pole changing) & rotor side (rotor resistance control), Applications of 3 ph. Induction motors

Unit 2: Performance and Characteristics of Three phase Induction Motor (09)

Losses & efficiency of 3 phase induction motor, power flow diagram with numerical treatment, No load& blocked rotor test, equivalent circuit of 3 phase induction motor, Phasor diagram of 3 phase induction motor, performance of 3 phase induction motor using circle diagram, Concept of operation of 3 phase induction motor as induction generator, Double cage induction motor along with its characteristics, cogging & crawling of 3 phase induction motor.

Unit 3: Single phase Induction Motors : (06)

Double field revolving theory, Construction and working of single phase induction motor (Split phase, capacitor start/run, shaded pole, repulsion type ,series motor, universal motor and hysteresis motor) Torque slip characteristics of all the above.

SECTION II

Unit 4: Special Purpose Motors: (05)

Construction and working of Synchronous Reluctance motor, switched reluctance motor, BLDC motor, Permanent magnet Synchronous motor, stepper motors, AC and Dc servo motors

Unit 5: Three Phase Alternator: (13)

Construction, principle of operation of three phase alternator, emf equation, parameters of armature winding. (resistance& leakage reactance), armature reaction (at unity, lagging zero and leading zero power factor), concept of synchronous reactance and synchronous impedance. Equivalent circuit of 3 phase alternator, alternator on load (resistive, inductive & capacitive) OC test & SC test on 3 Phase alternator, short circuit ratio, voltage regulation methods (emf, mmf, zero power factor and direct loading method) with numerical treatment, Losses and efficiency, power flow diagram, need of parallel operation, conditions for parallel operation, synchronizing procedures, hunting and oscillations in alternators,

Unit 6: Synchronous Motor: **(06)**

Principal of operation of three phase synchronous motor, staring methods of three phase synchronous motors (using prime mover and damper winding, Phasor Diagram of three phase synchronous motor at Unity, lagging and leading power factor, Effect of excitation on power factor and armature current, V & inverted V Curves, Operation of Synchronous motor as Synchronous Condenser, Application of three phase synchronous motor.

List of Experiments:

Minimum eight experiments from the following list of experiments should be performed in the laboratory:

1) Determination of efficiency & speed regulation of 3 phase SCIM by indirect loading method
2) Determination of equivalent circuit parameters of 3 Ph SCIM by conducting No Load& Blocked Rotor Test.
3) Determination of efficiency & speed regulation of 3 phase slip ring induction motor by direct loading method.
4) Determination of efficiency & speed regulation of 3 phase slip ring induction motor by indirect loading method.
5) Study of starters for 3 Ph induction motors
6) Performance of three phase induction motor under single phasing fault
7) Speed control methods of 3 Ph. SCIM
8) Speed control methods of 3 Ph. Slip ring I.M
9) Determination of efficiency & speed regulation of 1 phases induction motor
10) Determination of Voltage regulation of an alternator by EMF method
11) Determination of Voltage regulation of an alternator by MMF method
12) Determination of Voltage regulation of an alternator by ZPF method
13) Determination of Xd and Xq by Slip test
14) Performance of synchronous generator connected to infinite bus, under constant power and variable excitation & vice –versa
15) Determination of V and Inverted V curves of a synchronous motor
16) Determination of efficiency of synchronous motor by indirect loading
17) Determination of efficiency of synchronous motor by direct loading
18) Determination of load sharing by parallel operation
19) Determination of efficiency of Alternator by direct loading method

Recommended Books:

1) Electrical Machines, S. K. Bhattacharya, Tata Mc-Graw-Hill publication

2) Electrical Machines, I. J. Nagrath, D. P. Kothari, Tata Mc-Graw-Hill publication IV edition
3) V. K. Mehta "Principles of Electrical Machines". S. Chand Publishers, New Delhi
4) B. L. Theraja "A textbook of Electrical Technology" Volume II S. Chand Publishers, NewDelhi

Reference Books:

1) Electric Machinery, A. E. Fitzgerald, Mc-Graw Hill publications VI edition
2) Electrical Machines, Ashfaq Hussain, Dhanpat Rai & Sons
3) Electrical Machinery, P S Bhimbhra, Khanna Publications

Sr. No	Sem	Code No.	Subject	Credits
4	V	PCC-EE304	Power System-II	4

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of this course student will be able to,

1) **CO304.1** Explain the significance of per unit representation of system, electrical circuit and power factor improvement methods along with role of substation in smart grid
2) **CO304.2** Prepare the model of transmission line, generator and transformer of power system for single line diagram representation and per unit quantity calculation.
3) **CO304.3** Analyze the symmetrical and unsymmetrical faults in power system
4) **CO304.4** Apply load flow analysis to an electrical power system to achieve the best operation of existing system

Syllabus:

Course Code And Title	Teaching Scheme					Evaluation Scheme					
	L	T	P	Credit	Scheme	Theory (Marks)		Practical(Marks)		POE(Marks)	
						Max	Min .for Passing	Max	Min. for passing	Max	Min. for passing
PCC-EE-304 **Power System -II**	03	--	02	04	ISE	-	-	-	-	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	50	20	-	-

ISE: InSemesterEvaluation **MSE**: MidSemesterEvaluation **ESE**: End SemesterEvaluation

SECTION I

Unit 1: Power system Components **(6)**

Single phase representation of Balanced 3 phase Networks, OLD & Impedance & Reactance Diagram, Per Unit System- P.U. Representation of Transformer, P.U. Impedance Diagram ofPower system, Steady State Model of Synchronous Machine, Representation of Loads, Numerical treatment expected

Unit 2: Symmetrical Fault Analysis **(8)**

Short circuit transients on transmission line Short Circuit on Unloaded Synchronous machine, Short Circuit on loaded Synchronous machine **,**Selection Checklist for circuit breaker, Short circuit MVA, Algorithm for Short circuit studies **,** Z- Bus Formulation, Numerical treatment expected

Unit 3: Symmetrical Components **(8)**

Sequence Impedances Synchronous machine. Sequence Impedances Transformer, Construction ofSequence network of Power Systems, Numerical treatment expected

SECTION II

Unit 4: Unsymmetrical Fault Analysis **(10)**

Symmetrical component analysis of Unsymmetrical Faults, Analysis of Single Line to Ground (LG) fault, Line-To-Line (LL) fault, Double-Line-To-Ground (LLG) fault, One conductor open

fault, Bus Impedance Matrix for analysis of Unsymmetrical shunt faults, Numerical treatment expected

Unit 5: Load Flow Analysis **(10)**

Load flow problem, Gauss-Seidel Method, Newton-Raphson Method, Decoupled Load Flow studies, Fast Decoupled Load Flow studies. Comparison of Load Flow methods, Numerical treatmentexpected

Unit6: Power Factor Improvement and Substation Engineering **(6)**

Causes, Disadvantages of low power factor and power factor improvement Methods,SubstationGrounding, Direct Lightning stroke shielding of substations, Role of Substations in Smart Grids.

List of Experiments:

Minimum 10 experiments/simulations based on above curriculum should be performed.

Recommended Books:

1. Modern Power System Analysis , D. P. Kothari, I. J. Nagrath, Mc-Graw HillPublications, Fourth Edition
2. Power System Analysis, HadiSaadat, Tata Mc-Graw Hill
3. Electric Power substations Engineering, John D. McDonald, CRC Press , Third Edition

Reference Books:

1. Electrical Transients in Power Systems, Greenwood, Wiley Publication II edition
2. Power System Stability Vol I/II/III, Kimbark, Wiley Publication
3. Electrical Power Systems, AshfaqHussain, CBS publishers, New Delhi V edition
4. Electric Power Systems: A first course, Ned Mohan, Wiley Publication
5. Power System Operation & Control, K. Uma Rao, Wiley Publication

Sr. No	Sem	Code No.	Subject	Credits
5	V	PCC-EE305	Advanced Control System	4

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) **CO305.1 Select** the mode of controller according to the types of the compensator system.
2) **CO305.2 Design** a types of compensator by using root locus, bode plot and state space analysis.
3) **CO305.3 Demonstrate** a state space using controllability, Observability, Pole Placement techniques for Controller,Pole placement technique by Transformation method, Direct Substitution Method and by Ackermann's formula
4) **CO305.4 Differentiate** digital control system in Z-Transform and sampling with respect to S-Plane & Z-Plane.

Course Code andTitle	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE-305	03	---	02	04	ISE	---	---	---	----	---	---
Advanced Control System					MSE	30	12	---	---	---	---
					ESE	70	28	---	---	---	---

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION I

Unit –I Basics of Control Systems **[6]**

Classical Control Design Techniques Compensation techniques –Lag, Lead, Lead-Lag Controllers design in frequency Domain, Design of PID control system.

Unit –II Control System Design by Root Locus **[9]**

Review of Root Locus, Cascade Lead compensation, cascade Lag compensation, cascade Lead-Lag compensation, Series and parallel compensation, Effect of addition of poles and zeros, Design of Lead compensation based on Root Locus approach, Design of Lag compensation based on Root Locus approach, Design of Lead-Lag compensation based on Root Locus approach, Root Locus of system with dead time.

Unit –III Control System Design by Bode Plot **[9]**

Review of Bode Plot, Stability of system from Bode Plot, Cascade Lead compensation, cascade Lag compensation, cascade Lead-Lag compensation, Design of Lead compensation based on Bode Plot, Design of Lag compensation based on Bode Plot, Design of Lead-Lag compensation based on Bode Plot.

SECTION II

Unit –IV State Space Analysis **[6]**

State space representation of digital control system, Solving state space equation, Pulse

Transfer function.

Unit –V State Space Design **[9]**

Review of State Space, Controllability, Observability (Kalmans's test & Gilbert's test), Pole placement technique for controller design, State Feedback Law, Pole placement technique by Transformation method, Direct Substitution Method and by Ackermann's formula.

Unit –VI Digital Control System **[9]**

Review of Z-Transform, Z-Transform method for solving different equations, impulse sampling & data hold, pulse transfer function, Sampling theorem, mapping between S-Plane & Z-Plane, stability analysis, transient & steady state analysis

General Instructions:

Term Work- Minimum 8 to 10 MATLAB based experiments based on above syllabus should be performed.

Text books:

1. Control system: Principles and Design, M. Gopal, Tata McGraw-Hill Publication.
2. Modern Control Engineering, K. Ogata, Eastern Economy,5th edition 2011.
3. Control System Engineering, I. J. Nagrath and M. Gopal, New Age publication,5thedition, 2008.

Reference Books:

1. Automatic Control System, B. C.Kuo, Wiley Publication 8th edition.
2. Control System Engineering, Norman S. Nise, 4th Edition, John Wiley and Sons, 2004.
3. Digital Control and State Variable Methods, M.Gopal, Tata McGraw Hill, 3rd edition.
4. Control System Engineering, Gupta, Wiley Publications.
5. Control Engineering, K. P. Ramchandran, Wiley Publications.
6. Automatic Control Systems, Shridhar, Wiley Publications.

No	Sem	Code No.	Subject	Credits
6	V	PCC-EE306	Signals & Systems	4

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects

to meet the demands of industry and to provide solutions to the current real time problems.

COs:

306.1 Describe CT and DT signals and systems.

306.2 Distinguish concept of LTI system.

306.3 Analyze CT signals and systems using Laplace transform & DT signals and systems using Z transform.

306.4 Differentiate between Fourier Transform & Laplace Transform

306.5 Explain sampling theorem in time domain and frequency domain.

Syllabus:

Course Code andTitle	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE-306 Signals andSystems	03	01	-	04	ISE	-	-			-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	25	10	--	-

ISE: InSemesterEvaluation MSE: MidSemesterEvaluation ESE: End Semester Evaluation

SECTION I

Unit 1: Introduction to signals & systems (6)

Continuous & discrete signal: size of signal, signal operations, classification of signals, standard test signals, singularity functions. Continuous & discrete systems: Classification of systems, system models of Electrical systems

Unit 2: Description and analysis of system (7)

Continuous & discrete systems: zero state response, zero input response, convolution sum and convolution integral, graphical representation of convolution, block diagram representation of differential and difference equation, FIR and IIR systems

Unit 3: System Analysis using Laplace transform (6)

Laplace transform: A brief introduction to Laplace transform its properties and inverse Laplace transform, transfer function analysis, solution of LTI differential equation.

SECTION II

Unit 4: System analysis using Z-transform (6)

A brief introduction to Z–transform, its properties & inverse – Z transform, connection between Laplace transform and Z–transform, transfer function analysis, solution of LTI difference equation, and stability in Z-domain.

Unit 5: Fourier analysis of continuous & discrete signals **(8)**

Periodic representation by trigonometric Fourier series, Fourier spectrum, Dirichlet's condition, exponential Fourier series, exponential Fourier spectra, Parseval's theorem, Fourier transform and its properties, Relation between Fourier and Laplace Transform, Fourier spectrum. DTFT, Properties and symmetrical properties of DTFT, Convergence of DTFT: Gibb's Phenomenon.

Unit 6: Sampling **(4)**

Representation of continuous time signals by its samples, The sampling theorem, Reconstructionof signals from its sample s using interpolation, The effect of under sampling, aliasing, Discrete time processing of continuous time signals, Sampling in the frequency domain.

General Instructions:

1. Minimum number of tutorials should be 8 covering all topics.

Text Books:

1. Linear systems and signals, B. P. Lathi, Oxford University Press, 2nd edition, 2005
2. Signals and systems, Simon Haykin, Wiley Publications

Reference Books:

1. Alan V. Oppenheim, Alan S. Wilsky, S. Hamid Nawab -'Signals & system' -IInd Edition - Pearson Education.
2. Ramesh Babu 'Signals &system' , SciTech Publication.
3. Michael J. Roberts.-'Fundamentals of signals & systems'- Tata McGraw Hill, 2007.
4. Continuous and Discrete Time Signals and Systems by Mandal and Asif,Cambridge University Press
5. Signals and Systems by Dr.D.D.Shaha and Dr.A.C.Bhagali, MPH.
6. Signals and Systems by S. Palani, Ane Books Pvt. Ltd

SEMESTER VI

Sr. No	Code No.	Subject	Credits
1.	PCC-EE311	Digital Signal Processing	4
2.	OCE-EE312	Open Elective – II	3
3.	PCC-EE313	Electrical Machine Design	6
4.	PCC-EE314	Power System Stability And Control	5
5.	PCC-EE315	Electrical Drives- I	4
6.	PCC-EE316	Electrical Installations testing and maintenance	3
		Total	25

Sr. No	Sem	Code No.	Subject	Credits
1	VI	PCC-EE311	Digital Signal Processing	4

PSOs:

3) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
4) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

Course Outcomes:

311.1 Evaluate concept of convolution,DFT & FFT
311.2 Design DSP filters(FIR & IIR)
311.3 Analyze DSP filter
311.4 Distinguish DSP Processors
311.5 Expalin various modulation techniques.

Syllabus:

Course Code andTitle	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE-311					ISE	-	-	-	-	-	-
Digital Signal Processing					MSE	30	12	-	-	-	-
	04	--	-	04	ESE	70	28	-	-	--	-

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION I

Unit 1: Discrete Fourier Transform (10 Hrs)

DFT, Properties of DFT, Circular Convolution and Circular Co-relation using DFT and IDFT, Analysis of LTI System using Circular Convolution, Linear Convolution using Circular

Convolution. Overlap Save and Overlap add algorithm. FFT Algorithms – Radix 2: DIT-FFT and Radix 2: DIF.

Unit 2: FIR Filter Design & Realization (8Hrs)

Characteristics of FIR Filters. Properties of FIR Filters.FIR Design using Windowing Technique [Rectangular Window, Hamming Window and Hamming Window] FIR Design using Kaiser Window.FIR Design using Frequency Sampling Technique. FIR realization- Direct Form (Non-linear phase and Linear phase), Cascade and Parallel realization

Unit 3: IIR Filter Design & Realization (8 Hrs)

Introduction to IIR Filters, IIR Filter Designing using Impulse Invariant method and Bilinear Transformation method, Butterworth Filter approximation, Frequency Transformation. IIR realization- Direct form I and II, Cascade and parallel realization

SECTION II

Unit4: DSP Processors (6 Hrs)

Introduction, Architecture of DSP Processor, TMS320C67XX, Specifications, Comparison between general purpose and DSP Processors.

Unit 5:Amplitude Modulation (8 Hrs)

Base-band and carrier communication, amplitude modulation -DSB, AM, AM, SSB, VSB, carrier acquisition, super heterodyne AM receiver.

Unit 6: Angle Modulation (8 Hrs)

Concept of instantaneous frequency, band-width of angle modulated waves, generation of FMwaves, demodulation of FM, Interference in angle modulated systems, FM receiver.

General Instructions:

Minimum number of assignments should be 8 covering all topics.

Recommended Books:

1. Digital Signal Processing Principles, Algorithms and Application – By John G Prokis, Manolakis, Pearson Education publication
2. Digital Signal Processing Salivahanam, AVallavaraj, C. Guanapriya, TMH
3. Modern Digital and Analog Communication systems B.P. Lathi, 3rd Edition, Oxford

University Press 1998.

Reference Books:

1. Digital Signal Processing, Tarun Kumar Rawat (Oxford)
2. Digital Signal Processing Sanjeet Mitra, MGH
3. Digital Signal Processing- Dr. A. C. Bhagali, MPH
4. Digital Signal Processing- A. Anand Kumar.(PHI Publications)
5. Digital Signal Processing P. Ramesh Babu, Scitech publication

Sr. No	Sem	Code No.	Subject	Credits
2	VI	OCE-EE312	Open Elective – II ELECTRICAL ENERGY AUDIT AND CONSERVATION	3

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) CO312.1 **Understand** the basic concept, design, estimation, importance of energy audit and energy security
2) CO312.2 **Explain** practical aspects of monitoring and maintenance of transformer and grid substation
3) CO312.3 **Evaluation** of energy management, energy policy and energy audit report.
4) CO312.4 **Learn** various tools of demand control.

Syllabus:

Course Code and Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
OCE-EE-302 **Electrical Energy Audit and Conservation**	02	--	02	03	ISE	-	-	-	-	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	25	10	--	-

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION I

Unit I: Energy Audit system aspect (6 Hrs)

General philosophy, current practices, need of energy audit and its types ,methodology of energy audit and approach, Energy audit (definition as per energy conservation act), specific energy consumption, Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy, energy flow diagram(Sankey) , simple payback period, energy audit

procedure (walk through audit and detailed audit), energy audit report format

Unit II: Energy Audit in mechanical (7Hrs)

Pumps, types and application, unit's assessment, improvement option, parallel and series operating pump performance. Energy Saving in Pumps & Pumping Systems. Bloomers (Blowers) types & application, its performance assessment, series & parallel operation applications & advantages. Energy Saving in Blowers Compressors, types & applications, specific power consumption, compressed air system,& economic of system changes. Energy Saving in Compressors & Compressed Air Systems, Cooling towers, its types and performance assessment & limitations, water loss in cooling tower. Energy Saving in Cooling Towers.

Unit III: Tariff (5Hrs)

Types of tariff structure: LT and HT, special tariff, time-off-day tariff, Peak-of-day tariff, power factor tariff, maximum demand tariff, load factor tariff and availability based tariff (ABT), application of tariff system to reduce energy bill.

SECTION II

Unit IV: Energy Conservation basic (5 Hrs)

Energy scenario: Primary and secondary energy, energy demand and supply, national scenario, energy conservation and energy audit: concept and difference, energy conservation Act 2001: relevant clauses of energy conservation, BEE and its role, MEDA and its role, star labeling: Need and its benefits

Unit V: Energy conservation in Electrical Machine (6 Hrs)

Need for energy conservation in Induction motor and transformer, Energy conservation techniques in induction motor,Energy conservation techniques in Transformer, energy conservation equipment, Energy efficient motor: significant features, advantages ,application and limitation, Energy efficient transformer: amorphous transformer epoxy resin cast transformer/ Dry type of transformer

Unit VI: Energy Conservation in Mechanical System (7Hrs)

Potential energy, conservation forces, distinction between conservative and non-conservative forces, potential energy functions, spring potential energy, conservation of mechanical energy: gravitation ,spring , conservative force and potential energy function, conservative force for a Hypothetical Potential Energy Function , energy diagram, gravitational potential energy , scape speed

General Instructions:

1) Minimum number of assignments should be 6 covering all topics.
2) Submit one Energy audit report.

Recommended Books:

1) Guide book no 1 to 4 for national certification examination for energy manager and energy auditor BEE 4th edition
2) India – the Energy sector Henderson , P.D. University press Delhi.
3) Principle of power Systems by V K Mehta S chand Publication
4) Energy Management: W.R.Murphy, G.Mckay, Butterworths Scientific
5) Industrial Energy Conservation : D.A. Reay (Pergammon Press)

Reference Books:

1) Energy Audit and Management, Volume-I, IECC Press
2) Energy Efficiency in Electrical Systems, Volume-II, IECC Press
3) Energy Management Principles, C.B.Smith, Pergamon Press
4) Industrial Energy Conservation, D.A. Reay, Pergammon Press
5) Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Interscience
6) Efficient Use of Energy : I.G.C.Dryden (Butterworth Scientific)
7) Energy Economics -A.V.Desai (Wieley Eastern)
8) Industrial Energy Conservation Manuals, MIT Press, Mass, 1982
9) Energy Conservation guide book Patrick/Patrick/Fardo (Prentice Hall)

List of Experiment:

1) Computing efficiency of DC motor/Induction Motor/Transformer
2) Identify star labeled electrical apparatus and compare the data for various star rating.
3) Calculating the efficiency of boiler / blowers / compressors etc.
4) Study of APFC panel or Estimating the requirement of capacitance for power factor improvement.
5) Study of various energy efficient equipment like LED lighting devices, Energy Efficient motors,electronics ballast etc.
6) Soft starting of an induction motor
7) Study of Variable frequency drive based IM speed control for energy conservation.
8) Industry visit with an aim of
   (1) Studying various energy Audit systems prevailing in a particular industry/Organization
   (2) Identifying the various energy conservation methods useful in a particular industry
9) Studying the various energy conservation methods useful in power generation,
10) transmission anddistribution
11) Study of various measuring instruments used for energy audit : Lux meter, Power analyzer, flue gasanalyzer
12) Prepare a technical report on energy conservation act 2003

Sr. No	Sem	Code No.	Subject	Credits
3	VI	PCC-EE313	Electrical Machine Design	6

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs

At the end of the course the students should be able to:

1) **CO313.1** Recognize the fundamentals and essential standards to design electrical machine
2) **CO313.2** Design of entire transformer in detail, armature, field winding and Commutator of DC machines of stator core, stator winding and rotor bars of three phase induction motor, different parts of synchronous machine
3) **CO313.3** Demonstrate the applications in electrical machine design

Syllabus:

Course Code and Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE-313 Electrical Machine Design	04	01	02	06	ISE	-	-	-	-	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	50	20	50	20

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION -I

Unit 1: Fundamentals of electrical Machine Design (08 Hrs)

General consideration in the design, limitations in the design, output coefficient and their standard values for various machines, effect of size & ventilation on specific electric and magnetic loading. Different Indian Standard Specifications (ISS).

i) Magnetic circuits – Formulae for air and iron parts, calculations for magnetic circuits of electric machines, estimation of no load current, determination of leakage fluxes and reactance calculations, design of electromagnets.

ii) Mechanical Design – design of shafts, choice and types of bearings, determination of mechanical strength of rotors, design consideration of cooling fans and frames.

Unit 2: Design of Transformer **(8 Hrs)**

Classification of transformer (Core type, Shell type transformer), Comparison of core and Shell Type transformer, Single phase & 3 Phase transformer connections, Core Cross Section, Cooling of transformer, transformer Insulation using Oil & other materials. Output equation of transformer, Relation between Core Area & Weight of iron & copper, Design for minimum cost, Design for minimum loss or maximum efficiency, variation of Output &losses in transformer with linear Dimensions, Design of Core (rectangular core, Square &stepped Cores), Variation of Core Diameter, Selection of core areas & type of core, Choice of Flux Density, design of winding, Windows Space Factor, Windows Dimensions, Overall Dimensions, Simplified Steps for transformer Design. Resistance of Winding, Mechanical Forces, No load currents, No load current of 1ph transformer, No load current of 3phase transformer, Design of Tank with Tubes, Core Design, Winding Design, Window Area

Unit 3: Design of DC Machines **(8Hrs)**

Introduction & Applications, classification, Constructional Details, Stator, Armature, Commutator, Brush Gear, Design output Equation, Interdependence of specific & Electric Loadings, Selection of no of poles, Core Length, Armature diameter, Length of air gap, No of Armature coils, No of Armature Slots, Cross Section of Armature Conductors, Insulation of armature winding, Slots Dimensions, Poles Design (Areaof poles, Height of Poles), length of Inter poles, Losses & Efficiency (Rotational Losses ,Losses Stray load losses, Efficiency).Design of commutator and brush gear.

SECTION -II

Unit 4: Design of Three Phase Induction Motor **(8 Hrs)**

Main Dimension, stator Winding,(Turns Per Phase, Stator Conductors), Shapes of Stator Slots, No of Stator Slots, Area of stator Slots, Length of Mean Turn, Stator Teeth, Stator Core, Rotor Design, length of air gap, Relation For Calculations of Length of air gap, No of Rotor Slots,(Rules For Selecting Rotor Slots, Reduction of Harmonic torques), Design of rotor bars & Slots, (Rotor Bar Currents, Area of Rotor Bar, shapes& Size Of Rotor Slots, Rotor Slot Insulations), Design of End Rings.

Unit 5: Design of Synchronous Machine **(8 Hrs)**

Construction of water wheel and turbo alternators. Different parts and materials used for Synchronous machine, choice of electric and magnetic loadings, Output equation. Determination of diameter and length, effect of short circuit ratio on machine performance.

Unit 6: Computer Applications in electrical machine design (8Hrs)

Benefits of computer in machine design, methods of approach, optimization and computer aided design ofthree phase transformer, three phase induction motor, DC Motor and synchronous machine

Term work:

1) The term work shall consist of six drawing sheets and four sheets should be drawn using suitable software

Recommended Books:

1) A Course in Electrical Machine Design, A.K. Sawhney, DhanpatRai& sons New Delhi
2) 2.Principles of Electrical Machine Design, R. K. Agarwal, S. K. Katariya and sons.

Reference Books:

1. Electrical Machine Design Data Book, A Shanmugasundaram, G. Gangadharan, R Palani, 3rdEdition, Wiely Eastern Ltd., New Delhi
2. Computer Aided Design for Electrical Machines, Vishnu Murthy, B.S. Publications

Sr. No	Sem	Code No.	Subject	Credits
4	VI	PCC-EE314	Power System Stability And Control	5

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

1) CO314.1. Explain power system dynamics problems, current status and the need of system state classification, security analysis and factors affecting power system security and various methods to improve stability of power system
2) CO314.2. Analyze dynamic behavior of power system subjected to various disturbances from aggregated behavior of the many dynamic devices
3) CO314.3. Illustrate the concept of automatic frequency and voltage control strategies for single and two area case
4) CO314.4. Implement optimization techniques for obtaining load forecasting, economic load dispatch tasks and formation of unit commitment

Syllabus:

Course Code and Title	Teaching Scheme					Evaluation Scheme					
	L	T	P	Credit	Scheme	Theory (Marks)		Practical(Marks)		POE(Marks)	
						Max	Min.for Passing	Max	Min.for passing	Max	Min. for passing
PCC-EE314 **Power System Stability and Control**	04	--	02	05	ISE	-	-	-	-	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	50	20	-	-

ISE: In Semester Evaluation **MSE**: Mid Semester Evaluation **ESE**: End Semester Evaluation

SECTION I

Unit 1: Introduction to Power System Stability & Control (6 Hrs)

Power System Stability, Classification Power system Stability, State Operation & System Security :-Review, System Dynamics Problems Current Status & Recent Trends, System Model, Dynamics of Synchronous Machine [Swing equation]NUMERICALS EXPECTED.

Unit 2:Power system Stability (10 Hrs)

Factors affecting Transient Stability, Swing Equation Solution [Point By Point Method, Equal Area Criteria], Transient Stability Limit, Critical Clearing Angle and Critical Fault Clearing Time, Fault Shunts and Impedances of Fault Shunts, Multi Machine Stability, NUMERICALS EXPECTED.

Unit 3:Methods of Improving Stability (10 Hrs)

Transient Stability Enhancements:- High Speed Fault clearing, Reduction of transmission system reactance , regulated shunt compensation , dynamic Braking , Reactor Switching, Controlled system Separation & Load Shedding – High Speed Excitation & Control, Discontinuous Excitation Control, Small Signal Stability Enhancement-Power system Stabilizers, Supplementary Control of SVC.

SECTION II

Unit 4:Power System Control (10 Hrs)

Load frequency control (Single and two area case) modeling of generator ,governor, prime mover, Load frequency control and economic dispatch, automatic generation control, steady state analysis and dynamics response of an isolated power systems, automatic voltage control, reactive power control.

Unit 5:Optimal Power System Operation (8Hrs)

Load duration curve, load factor, diversity factor, plant capacity factor, plant utilization factor, Load Forecasting, Optimal Unit commitment, Economic load Dispatch [with/without Transmission line Losses & Generator Limits], NUMERICALS EXPECTED.

Unit 6: Power System Security (4 Hrs)

System State Classification, Security Analysis, Contingency Analysis, Sensitivity Factors, Factors Affecting Power System Security.

General Instructions:

1. The number of students per batch should be as per the university pattern forpractical batches.
2. Minimum number of assignments should be 8 covering all topics.

List of Experiments

Minimum 10experiments /simulations based on above curriculum should be performed.

Recommended Books:

1. Modern Power System Analysis, D. P. Kothari, I. J. Nagrath, Mc-Graw Hill Publications,Fourth Edition 2012
2. Power System Analysis, HadiSaadat, Tata Mc-Graw Hill
3. Power System Operation and Control, Dr. K Uma Rao, Wiley India Publication

Reference Books:

1. Power System Stability and Control, Prabha Kundur, TMH Publications.
2. Computer Modeling of Electrical Power Systems, Arrilaga, Wiley Publications, 2ndedition
3. Power Generation, Operation and Control, Allen J. Wood, Wollenberg, Wiley India 2ndedition
4. Power System Dynamics, K. R. Padiyar, BS Publications, Second Edition
5. Electrical Power Systems, Weedy, Wiley Publications, 5th edition
6. Power System Harmonic Analysis, Arrilaga, Wiley Publications

Sr. No	Sem	Code No.	Subject	Credits
5	VI	PCC-EE315	Electrical Drives- I	4

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects

to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1. CO315.1 Understand the concept, classification, Parts and advantages of electrical drives with types of loads and conditions of dynamic and stability considerations.
2. CO315.2 Remember the basics of DC motor and the speed control methods of D.C. motor by Single & Three-Phase Converters.
3. CO315.3 Identify the chopper operation, configuration and control techniques to control the DC Motor.
4. CO315.4 Appraise the voltage and frequency control method of Induction motor drive in Stator side control and rotor resistance control method of Induction motor drive in Rotor side control.
5. CO315.5 Appraise the speed and frequency control method of synchronous motor and special drives.

Syllabus:

Course Code andTitle	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE-315 **Electrical Drives – I**	03	--	02	04	ISE	-	-	-	-	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	25	10	50	20

ISE: In Semester Evaluation **MSE:** Mid Semester Evaluation **ESE:** End Semester Evaluation

SECTION I

Unit 1: Introduction to Electrical drives: (4Hrs)

Concept of Electrical drive, Classification of Electrical drives, Parts of Electrical drive, Advantages of Electrical Drives, Types of loads and their characteristics, Motor load interaction, Dynamic conditions in Electrical drives, Stability considerations in Electrical drives

Unit 2: Control of DC motor (6Hrs)

a) Single Converters

Introduction, review of Classification of dc motors and their speed control, Electric braking of dc motors, Block Diagram of Electrical Drive, Single phase Controlled Converter for Separately Excited dc motor Drives, DC series Motor Drives, Introduction to 4 quadrant operation of dc motor, Single phase Dual Converter for Four Quadrant Operation

b) Three-Phase Converters

Three phase semi converter Fed with Separately Excited dc Motor, Three Phase Full Converter Fed with Separately Excited dc motor, Three phase semi converter Fed dc Series Motor, Three Phase Full- converter Fed dc Series Motor

c) Chopper

Introduction, Principle of chopper Operation, Classification of Chopper Circuits (single quadrant and four quadrant operation of chopper), Performance of chopper Fed Separately Excited dc Motors, introduction to closed loop system

Unit 3:Induction Motor Drives: Stator side control: (8Hrs)

a) Stator voltage control:

Introduction, review of types of 3 phase Induction motors, Torque-speed characteristic of 3 phase Induction motor, Stator Voltage Control using different 3 phase AC voltage controllers, Introduction to closed loop control using stator voltage control

b) Stator Frequency control:

Introduction, Variable Frequency Characteristics, Block Diagram of Variable Frequency Speed Control, V/f control, Voltage Source Inverter (VSI) fed induction motor drive, Braking and multi quadrant operation of VSI fed induction motor drive, Variable Frequency Control From a current Source inverter (CSI), comparison of VSI and CSI drives, Introduction of Closed loop speed Control for VSI fed Induction Motor Drives, Basic operation of Pulse Width Modulated Inverter Fed Induction motor Drive

SECTION II

Unit 4:Induction Motor Drives: (6Hrs)

Rotor side control:

Introduction, Conventional Rotor Resistance Control, Rotor Resistance Control using power converters, Slip Power Recovery Schemes (Static Kramer drive, Static Scherbius drive), Introduction to Vector control of Induction motor

Unit 5: Synchronous Motor Drives and Brushless DC Motor Drives: (6Hrs)

Introduction, review of synchronous motor types & operation, Speed Control of Synchronous Machinesin true synchronous mode, Load- commutated Inverter Fed Synchronous Motor Drive, Closed loopSpeed control of Synchronous Motor using Load commutated Inverter, Operation of Voltage SourceInverter Fed Synchronous Motor Drive, Introduction to Brushless DC Drives.

Unit 6: Special Drives : (6Hrs)

Switch Reluctance Motor Drives, Torque Equation, Converter Circuits, Operating modes and

Applications. Solar Panel V-I Characteristics, Solar Powered Pump, Maximum Power Point Tracking and Battery operated Vehicles.

General Instructions:

1. The number of students per batch should be as per the university pattern forpractical batches.
2. Minimum number of assignments should be 8 covering all topics.

List of Experiments

Minimum eight experiments and two simulations based on above curriculum should be performed

Recommended Books:

1. Power Semiconductor Drives, S. Sivanagaraju, M. B. Reddy, A. M. Prasad, PHI, Delhi
2. Fundamentals of Electrical Drives, G. K. Dubey, CRC Press, II edition
3. Electric Drives, N. K. De, P. K. Sen
4. Electric Drives: Concepts & Applications, VedamSubrahmanyam, Tata Mc-Graw-Hill

Reference Books:

1. Electrical Machines & Drives, A First course, Ned Mohan, Wiley Publications
2. Power Electronics: Converters, Applications & Design, Ned Mohan, Wiley Publications
3. Power Electronics & Variable frequency drives: Technology & applications, Bose, Wiley Publications
4. Power Electronics: Circuits, Devices, and Applications, M. H. Rashid, Prentice Hall, III edition
5. Principles of Electric Machines & Power Electronics, P. C. Sen, Wiley Publications, II edition
6. B.K. Bose, “Modern Power Electronics and AC Drives”, Prentice Hall of India Pvt.Ltd.Publications.

SEMESTER VII

Sr. No	Code No.	Subject	Credits
1.	PCC-EE401	FACTS	03
2.	OCE-EE402	Open Elective-I	04
3.	PCC-EE403	Power Quality and Harmonics	04
4.	PCC-EE404	Computer Methods in Power Systems	04
5.	PCC-EE405	Advanced Switchgear and Protection	04
6.	PCC-EE406	Industrial Training & Presentation	02
7.	PCC-EE407	Project Phase-I	04
		Total	25

r. No	Sem	Code No.	Subject	Credits
1	VII	PCC-EE401	FACTS	03

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) CO401.1 Classify the different types of compensators in each category.
2) CO401.2 Sketch the static shunt compensators, static series compensators and combined compensators.
3) CO401.3 Compare the Static voltage and phase angle regulators.
4) CO401.4 Construct the special purpose FACTS controllers and custom power.

Syllabus:

Course Code And Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE-401 FACTS	03	--	--	03	ISE	-	-	--	--	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	-	-	--	--

SECTION-I

Unit No I: **(7 Hrs)**

Introduction to FACTS: Need of transmission interconnection, power flow in ac system, loading limit, importance of FACTS, transmission network, introduction to basic types of FACTS controller, comparison of HVDC and FACTS.

Unit No II: **(8 Hrs)**

Statics shunt compensators, SVC: Objectives of the shunt Compensation, Static VAR compensators (TSC, TCR, FC-TCR, TSC, TCR), switching transient in TSC, functional control Scheme for FC-TCR and TSC-TCR.

Unit No III: **(10 Hrs)**

Static Synchronous compensator STATCOM: basic principal and control scheme for STATCOM, hybrid VAR generation, comparison between STATCOM and SVC.

Section –II

Unit No IV: **(8 Hrs)**

Static Series compensators: objectives of the Series compensation ,variable impedance type series compensator GCSC and TSSC, operating control schemes for GCSC and TSSC , SSR (sub synchronous resonance) , switching converter type series compensators SSSC , internal schemes for SSSC, external control schemes for series reactive compensators , characteristics of series compensator .

Unit No V: **(8 Hrs)**

Static voltage and phase angle regulation TCVR and TCPAR: Objective of voltage and phase angle regulators, thyristors controlled voltage and phase angle Regulator, switching converter based voltage and phase angle regulators.

Unit No VI: **(7 Hrs)**

Combined compensator: UPFC and IPFC. UPFC – basic principle and reactive Power control scheme for UPFC, comparison of UPFC to Series compensator and phase angle regulations. IPFC-basic operating principle, control structure and its applications.

Text Books/Reference Books:

1. Understanding FACTS - Concept and Technology of flexible AC Transmission systems.

N.G. Hingorani& L. Gywgyi IEE Press.

2. Static Reactive power compensation : T.J.E. Miller, John Wiley and sons New
3. FACTS : Yong Huasoug, Allan Johns
4. Flexible AC Transmission System: Modeling and Control -2nd Edition Springer by Xiao-ping Zhang.
5. Facts Controller In Power Transmission And Distribution by K.R.Padiyar Edited by New Age International Publishers
6. Flexible AC Transmission System By Sushmita Panda

Sr. No	Sem	Code No.	Subject	Credits
2	VII	OCE-EE402	Open Elective-I **ELECTRIC VEHICLE**	04

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

1) CO402.1 Explain key vehicle requirements and working of different configurations of electric vehicles, hybrid electric vehicles along with their components and different energy management strategies
2) CO402.2 Elaborate the concept of electric vehicle drive system, electric propulsion system and battery performance parameters along with different types of energy storage system
3) CO402.3 Analyze fundamental electrochemistry of battery operation and performance requirements for hybrid and full electric vehicles
4) CO402.4 Compare various industry and regulatory standards for hybrid vehicle components, batteries and charging system along with different types of battery testing.

Syllabus:

Course Code And Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
OCE-EE-402 EV	03	01	--	04	ISE	-	-	--	--	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	25	10	--	--

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION-I

Unit I: Introduction to EV & HEV (6 Hours)

Past, Present & Feature of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs & HEVs, Comparison of EV Vs IC Engine. EV System: EV Configuration: Fixed & variable gearing, single & multiple motor drives, In-wheel drives.

Unit II: Electric Drive and Electric Propulsion System (10 Hours)

Basic concept of electric traction, introduction to various electric d rive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Unit III: Energy Management Strategies (08 Hours)

Introduction to energy management strategies used in hybrid and electric vehicles, classificationof different energy management strategies, comparison of different energy managementstrategies, implementation issues of energy management strategies.

SECTION-II

Unit IV: Energy Storage System (06 Hours)

Batteries: Lead Acid Battery, Nickel based batteries, Sodium based batteries, Lithium based batteries – Li-ion & Li-poly, Metal Air Battery, Zine Chloride battery; Ultra capacitors; Flywheel Energy Storage System; Hydraulic Energy Storage System; Comparison of different Energy Storage System Suggested reading: Study of different types of batteries

Unit V: Battery Characteristics & Parameters (08 Hours)

Cells and Batteries- conversion of chemical energy to electrical energy- Battery Specifications: Variables to characterize battery operating conditions and Specifications to characterize battery nominal and maximum characteristics; Efficiency of batteries; Electrical parameters Heat generation- Battery design Performance criteria for Electric vehicles batteries- Vehicle propulsion factors- Power and energy requirements of batteries- Meeting battery performance criteria- setting new targets for battery

performance.

Unit VI: Battery Testing, Disposal & Recycling (08 Hours)

Chemical & structure material properties for cell safety and battery design, battery testing, limitations for transport and storage of cells and batteries, Recycling, disposal and second use of batteries. Battery Leakage: gas generation in batteries, leakage path, leakage rates. Ruptures: Mechanical stress and pressure tolerance of cells, safety vents, Explosions: Causes of battery explosions, explosive process, Thermal Runway: High discharge rates, Short circuits, charging and discharging. Environment and Human Health impact assessments of batteries, Generalrecycling issues and drivers, methods of recycling of EV batteries. Industry and regulatory standards for hybrid vehicle components, batteries, and charging systems.

One visit to commercial electric vehicle showroom in the local area

One industrial visit to battery manufacturing industry in the local area.

Sr. No	Sem	Code No.	Subject	Credits
3	VII	PCC-EE403	Power Quality and Harmonics	04

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs

At the end of the course the students should be able to:

1) **CO403.1 Discuss** the importance of power quality and Total Harmonic Distortion in power system.
2) **CO403.2 Design** the harmonic suppression filter.
3) **CO403.3 Explain** the Mitigation of Voltage Sag, interruptions and different Harmonic Measurement Techniques.
4) **CO403.4 Choose** the grounding practices and use of signal reference grid.

Syllabus:

Course Code And Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE-403 PQH	03	01	--	04	ISE	-	-	--	--	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	25	10	--	--

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

Section –I

Unit I **(8 hrs)**

Introduction to Power Quality: Desired feature of Electrical Power Supply, Power Quality related issues in distribution systems, loads and theirs characteristics, electromagneticphenomena,voltage sags/swells, waveform distortions, unbalance, flicker, notches, unbalanceand load balancing.

Unit II **(8 hrs)**

Fundamental of Harmonics: causes for generation of harmonics, effect of harmonic on systems, types and characterization of Harmonics, THDs, influence on power factor, interference with communication network and harmonic indices.

Unit III **(9 hrs)**

Harmonics Suppression Filters: Shunt Passive Filters, Design Considerations and case studies, Voltage / Current Source active filters, types: shunt, series and Hybrid Filter, their characteristicsand comparison.

Section –II

UNIT IV **(8 hrs)**

Mitigation of Voltage Sag and interruptions: End user issues, UPS systems, Ferro resonant Transformers, Super Conducting Storage Devices, Dynamic Voltage Restorer and Application of D-STATCOM.

UNIT V **(7 hrs)**

Harmonic Measurement: Instrumentation techniques, Analog and Digital Methods, presentation of harmonic data and Interruption, case studies, Harmonic Standard and future trends.

UNIT VI **(8 hrs)**

Power Quality Monitoring: Power Quality Analyzer, Acceptability of Power Supply- tolerance envelops of CBEMA and ITIC, reliability indices, typical wiring and grounding problems, grounding practices and use of signal reference grid.

General Instructions:

1. The number of students per batch should be as per the university pattern for practical batches.

2. Minimum number of assignments should be 8 covering all topics.

List of Experiments:

Minimum five experiments based on Hardware and five experiments based onSimulations and at least three experiments based on Interfacing.

Textbook

1) Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.WayneBeaty, „Electrical Power Systems Quality" McGraw Hill, 2003.
2) Dr. Mahesh Kumar, IIT Chennai, Power Quality in Distribution Systems.
3) A. Ghosh and G. Ledwich, Power Quality Enhancement using Custom Power Devices. Boston, MA: Kluwer, 2002.

References:

1) J. Arrillaga, N.R. Watson, S. Chen, 'Power System Quality Assessment', (New York: Wiley, 1999).
2) G.T. Heydt, 'Electric Power Quality', 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications,1994).
3) George J. Wakileh, "Power System Harmonics - Fundamentals, Analysis & filter Design" Springer.
4) M.H.J Bollen, „Understanding Power Quality Problems: Voltage Sags and Interruptions", (New York: IEEE Press, 1999).
5) Angelo Baggini, Handbook on Power Quality, John Wiley & Sons, New Jersey,USA, 2008.

Sr. No	Sem	Code No.	Subject	Credits
4	VII	PCC-EE404	Computer Methods in Power Systems	04

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs

1) CO404.1 Analyze the complex electric circuits by converting them using network graph theory and incidence matrices

2) CO404.2 Compute the admittance and impedance matrix using computer solution methods
3) CO404.3 Apply load flow analysis to an electrical power network to determine the operating state of system
4) CO404.4 Analyze the various types of simultaneous faults by two port network theory along with balanced and unbalanced fault condition by two component method for to obtain the network behavior results.

Course Code And Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE-403 CMPS	03	--	02	05	ISE	-	-	--	--	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	25	10	50	20

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION-I

Unit 1:-Network Formulation and Graph Theory (7Hrs)

Introduction, Elementary graph theory – oriented graph, tree, co-tree, basic cut-sets, basic loops; Incidence matrices – Element-node, Bus incidence, Tree-branch path,Basic cut-set, Augmented cut-set, Basic loop and Augmented loop, Numerical Treatment Expected.

Unit 2:- Computer Solution Methods Using the Admittance Matrix (5Hrs)

Introduction, Y_{BUS} formation by Direct and Singular Transformation Methods, Primitive network – impedance form and admittance form, Numerical treatment expected.

Unit 3:- Computer Solution Methods Using the Impedance Matrix (6Hrs)

Introduction Z_{BUS} formation by Step by step algorithm Methods, impedance matrix algorithm, adding a radial impedance to the reference node, adding a radial branch to anew node, closing a loop to the reference, closing a loop not involving the reference,Formation of Z_{LOOP} Matrix & Z_{BR} Matrix Numerical treatment expected.

SECTION-II

Unit 4:- Load flow Studies **(6Hrs)**

Introduction, Bus and Types of buses, Impact of computers, orientation of engineering problems to computers, Power Flow equation, Classification of buses, Operating constraints, Data for load flow, Gauss-Siedal Method – Algorithm and flow chart, Newton Raphson‟s Method– Algorithm and flow chart, Fast Decoupled Method – Algorithm and flow chart.

Unit 5:-Simultaneous Faults **(7Hrs)**

Simultaneous Faults by Two-Port Network Theory- Two port networks, interconnection of two port networks, simultaneous fault connection of sequence networks, series-seriesconnection (Z-type faults), Parallel -parallel connection (Y-type faults), series-parallel connection (H-type faults).

Unit 6:-Analytical Simplification **(5Hrs)**

Two component method, Shunt Faults- SLG Fault, LL Fault, DLG Fault, Three phasefault, Series Faults- 2LO Fault, 1LO Fault.

Term-work:

Minimum 8 to 10 experiments based on analysis using Computer Software such as MATLAB/SCILAB.

Reference Book

Sr No	Title	Author	Publications
1	Analysis of Faulted Power Systems	Paul.M. Anderson	IEEE Press
2	Power System Analysis	Grainger & Stevenson	Tata McGraw-Hill
3	Computer Techniques and Models in Power Systems	K. Uma Rao	I.K. International Publishing House
4	Power System Analysis	HadiSaadat	Tata McGraw-Hill

Sr. No	Sem	Code No.	Subject	Credits
5	VII	PCC-EE405	Advanced Switchgear and Protection	04

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs

At the end of the course the students should be able to:

1) CO405.1Explain the concept & different types of CB, relays, fuse
2) CO405.2 Apply the knowledge of transformer protection & generator protection
3) CO405.3 Analyze the types of over current protection& differential protection

Syllabus:

Course Code And Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE-405 SAP	03	--	02	04	ISE	-	-	--	--	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	25	10	--	--

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

Section –I

Unit No. 01 Circuit Breakers: (08 Hrs)

Voltage-current characteristics of arc, Principles of DC and AC arc interruption, high resistance and current zero interruption, arc voltage, Transient Restriking Voltage (TRV), Recovery voltage, RRRV, current chopping, resistances witching, capacitive current interruption.Classification of circuit breakers, brief study of construction and working of bulk oil and minimum oil CB, Air break and Air Blast CB, SF6 and Vacuum CB, HVDC breakers, ratings of CB and testing of CB Fuse: Rewirable and HRSC fuse, fuse characteristics, application and selection of fuse.

Unit No. 02 Relays: (08 Hrs)

Selectivity, sensitivity, reliability and speed of operation of a relay, CT burden calculation, attracted

armature, balanced beam, moving coil relays, theory and construction of induction disc and induction cup relays, numerical relays, microprocessor based relaying.

Unit No. 03 over current Protection: (06 Hrs)

Plug setting, time setting, radial feeder and ring mains protection, earth fault and phase fault, Directional relay, and microprocessor based over current relay.

Section –II

Unit No. 04 Differential Relays: (06 Hrs)

Circulating current and opposed voltage principles, percentage differential relay, line protection, Carrier aided Protection scheme.

Unit No. 05 Transformer protection: (08 Hrs)

Problems associated with percentage differential protection, harmonic restraint and harmonicBlocking schemes, restricted earth fault protection, Buchholz relay for incipient faults.

Unit No.06 Generator protection: (12 Hrs)

Stator earth fault, phase fault, stator current unbalance (NPS) protection, Rotor overheating, earth fault protection, excitation failure and protection against motoring, generator-transformer unit protection. Distance protection: Impedance, reactance and admittance characteristics, relay settings for 3-zone protection, out of step blocking scheme, blinder relay, numerical relays for transmission line protection, microprocessor based impedance, reactance and mho relays. Over voltage Protection: Causes of over voltages, surge arrestors and absorbers, metal oxide (ZnO) arrestors, insulation co-ordination in a power system.

List of Experiments:

1) Drawing sheet showing construction of MOCB, ABCB, SF6CB and Vacuum CB.
2) Drawing sheet or Generator and transformer protection schemes.
3) Study of construction and working of induction disc type relays.
4) Plotting of I αt characteristics of an IDMT over current or E/F relay.
5) Experimental study of working of electromechanical over voltage relay.
6) Experimental study of working of a Directional over current relay.
7) Experimental realization of microprocessor based over current relay.
8) Experimental realization of microprocessor based over-voltage/ Under Voltage relay.
9) Experimental realization of microprocessor based impedance relay.
10) Experimental realization of microprocessor based Directional over current relay.

Text books and References:

1) Power System Protection and Switchgear: B.RamandB. N.Vishwakarma
2) Fundamentals of Power System Protection: Y.G.Paithankar, S.R.Bhide
3) Switchgear and Protection: Sunil.S. Rao, Khanna Publications
4) Digital Protection: L.P.Singh
5) Switchgear and Protection: M.V. Deshpande

SEMESTER VIII

Sr. No	Code No.	Subject	Credits
1.	PCC-EE411	Management & Entrepreneurship Development	03
2.	OCE-EE412	Elective II	04
3.	PCC-EE413	HVDC Systems	04
4.	PCC-EE414	EHVAC	04
5.	PCC-EE415	Electrical Generation, Utilization & Traction	04
6.	PCC-EE416	Seminar	02
7.	PCC-EE417	Project Phase-II	04
		Total	25

Sr. No	Sem	Code No.	Subject	Credits
1	VII	PCC-EE411	Management & Entrepreneurship Development	03

PSOs:

5) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
6) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) CO411.1 **Understand** the basic concept of nature of management.
2) CO411.2 **Describe** the process of organizing and importance of staffing.
3) CO411.3 **Explain** the requirements of directing and controlling.
4) CO411.4 **Evaluate** the importance of social responsibilities of Business.
5) CO411.5 **Follow** rules of modern small business enterprises.
6) CO411.6 **Describe** feasibility report for a project.

Syllabus:

Course Code And Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		TW (Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE407 MED	03	--	--	03	ISE	-	-	--	--	-	-
					MSE	30	12	50	20	-	-
					ESE	70	28	-	-	--	--

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

Section –I

Unit-01 Management and Planning (6 hrs)

Management: Nature and Functions of Management – Importance, Definition, Management Functions, Levels of Management, Roles of Manager, Managerial Skills, Management & Administration, Management as a Science, Art & Profession. Planning: Planning-Nature, Importance, Types, Steps and Limitations of Planning; Decision Making – Meaning,Types and Steps in Decision Making.

Unit-02 Organizing and Staffing (6 hrs)

Organizing and Staffing: Organization-Meaning, Characteristics, Process of Organizing, Principles of Organizing, Span of Management (meaning and importance only), Departmentalization, Committees–Meaning, Types of Committees; Centralization V/S Decentralization of Authority and Responsibility; **Staffing**-Need and Importance, Recruitment and selection Process.

Unit-03 Directing and Controlling (6 hrs)

Directing and Controlling: Meaning and Requirements of Effective Direction, Giving Orders; Motivation- Nature of Motivation, Motivation Theories (Maslow‟s Need- Hierarchy Theory and Herzberg‟s Two Factor Theory); Communication – Meaning, Importance and Purposes of Communication; Leadership-Meaning, Characteristics, Behavioral Approach of Leadership; Coordination-Meaning, Types, Techniques of Coordination; Controlling – Meaning, Need for Control System, Benefits of Control, Essentials of Effective Control System, Steps in Control Process.

Section –II

Unit-04 Social Responsibilities of Business (06 hrs)

Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance. Entrepreneurship: Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics

of successful Entrepreneur, Classification of Entrepreneurs, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship.

Unit -05 Modern Small Business Enterprises (04 hrs)

Modern Small Business Enterprises: Role of Small Scale Industries, Impact of Globalization and WTO on SSIs, Concepts and definitions of SSI Enterprises, Government policy and developmentof the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Ancillary Industry and Tiny Industry (Definition only).

Unit-06 Projects Management (08 hrs)

Projects Management: A Project. Search for a Business idea: Introduction, Choosing an Idea, Selection of product, The Adoption process, Product Innovation, Product Planning and Development Strategy, Product Planning and Development Process. Concepts of Projects and Classification: Introduction, Meaning of Projects, Characteristics of a Project, Project Levels, Project Classification, Aspects of a Project, The project Cycle, Features and Phases of Project management, Project Management Processes. Project Identification: Feasibility Report, Project Feasibility Analysis. Project Formulation: Meaning, Steps in Project formulation, Sequential Stages of Project Formulation, Project Evaluation.

Sr. No	Sem	Code No.	Subject	Credits
2	VII	OCE-EE412	Elective II Electrical Maintenance and Electrical Energy Audit	04

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) CO412.1 **Understand** the basic concept, design, estimation, importance of energy audit and energy security
2) CO412.2 **Explain** practical aspects of monitoring and maintenance of transformer and grid substation
3) CO412.3 **Evaluation** of energy management, energy policy and energy audit report.
4) CO412.4 **Learn** various tools of demand control.

Syllabus:

Course Code And Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
OCE-EE-412	03	--	--	03	ISE	-	-	--	--	-	-
EMEEA					MSE	30	12	-	-	-	-
					ESE	70	28	-	-	--	--

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION-I

Unit No I: Introduction to Electrical Maintenance (10 Hrs)

Types of maintenance, maintenance schedules, procedures, Maintenance of Motors: Overhauling of motors, preventive maintenance, and trouble shopping of electric motors.Maintenance of Transmission and Distribution System, danger notice, caution notice permit towork, arranging of shutdowns personally and temporary earths cancellation of permit andrestoration of supply, Patrolling and visual inspection of lines – points to be noted duringpatrolling from ground: special inspections and night inspections, Location of faults usingMeggar, effect of open or loose neutral connections provision of proper fuses on service linesand their effect on system, causes and dim and flickering light.

Unit No II: Maintenance of Distribution Transformers: (08 Hrs)

Transformer maintenance and points to be attended to be attended to in respect of various itemsof equipment, Checking of insulation resistance transformer oil level and BDV test of oil,measurement of earth resistance.

Unit No III: Maintenance of Grid Substations: (06 Hrs)

Checking and maintenance of bus bars, isolating switches, HT/LT circuit breakers, LT switches, Power Transformers.

Section –II

Unit No IV: General Aspects of Energy Management and Energy Audit (06 Hrs)

Definition, Need and types of energy audit. Energy management (audit) approach-understandingenergy costs, bench marking, energy performance, matching energy use to requirement,maximizing system efficiencies, optimizing the input energy requirements, fuel & energysubstitution, energy audit

instruments

Unit No V: Energy Audit Methodology & Recent Trends (10 Hrs)

Current Practices, Integration of two or more systems, Switching of Energy Sources,Reportwriting, preparations and presentations of energy audit reports, Post monitoring of energyconservation projects, MIS ,Case-studies / Report studies of Energy Audits. Guidelines forwriting energy audit report, data presentation in report, findings recommendations, impact ofrenewable energy on energy audit recommendations. Case studies of implemented energy costoptimization projects in electrical utilities as well as thermal utilities.

Unit No VI: Energy Efficiency in Electrical Utilities (06 Hrs)

Electrical system: Electricity billing, electrical load management and maximum demand control, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. **Electric motors**: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

Lighting System: Light source, choice of lighting, luminance requirements, and energy conservation avenues.

Text Books/Reference Books:

1. Testing, Commissioning Operation and Maintenance of Electrical Equipment : S Rao,Khanna Technical Publication ,New Delhi.
2. Preventive Maintenance of Electrical Apparatus : SK Sharotri, Katson PublishingHouseLudhiana
3. Electric Energy Generation, Utilisation and Conservation Sivaganaraju, S Pearson,New Delhi, 2012
4. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
5. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A WileyInterscience Publication.

Sr. No	Sem	Code No.	Subject	Credits
3	VII	PCC-EE413	HVDC Systems	04

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) CO413.1 **Explain** about HVDC.
2) CO413.2 **Explain** the analysis of HVDC converters.
3) CO413.3 **Explain** The Multi Terminal HVDC Systems.
4) CO413.4 **Apply** the knowledge of reactive power and design the filters.
5) CO413.5 **Explain** HVDC Cables and simulation of systems.

Course Code And Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE413 HVDC	3	--	1	4	ISE	-	-	--	--	-	-
					MSE	30	12	25	10	-	-
					ESE	70	28	--	--	50	20

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

SECTION-I

Unit-I General Background: (7 Hrs)

Trends in transmission Voltages, Hierarchical Levels in transmission and distribution, Standard rated voltage of EHV-AC and HVDC, General aspects HVDC. Transmission: Constitution of EHVAC and DC links, Kinds of DC links, HVDC projects in India and abroad, limitations and advantages of HVDC transmission over EHVAC, Layout of HVDC station. Deep Hole Ground Electrode, Electrolytic Corrosion, factors for General Design of Electrodes.

Unit-II Grid Control and Characteristics: (7Hrs)

Grid control of thyristor, valve-Analysis with grid control with no overlap, overlap less than 60 degrees and overlap greater than 60 degrees. Basic means of control, Power reversal, manual control and its limitations-constant current versus constant voltage Control, desired features of control, actual control characteristics-constant minimum ignition angle, current and extinction angle controls –power control and current limits.

Voltage Dependent Current Limiter (VDCOL), Comparison of Converters - CSC & VSC systems

Unit-III Protection: (4Hrs)

Disoperation of converters-short circuit on a rectifier – commutation failure, causes and remedies – Protection of HVDC system, DC rectors, damper circuits, Over current protection and over-voltage protection, clearing fault and reenergizing the line.

SECTION-II

Unit-IV Harmonics and Filters: (5Hrs)

Characteristic and uncharacteristic harmonics-causes, consequences and suppression-Troubles caused by harmonics, Harmonic filters- Types, Location, series or shunt, sharpness of tuning, Quality Factor Q for L, C & RLC filter

Unit-V Reactive Power Compensation: (6 Hrs)

Reactive Power Requirement of HVDC Converter- reactive Power balance in HVDCsubstations-Effect of angle of advance and extinction angle on reactive power requirement ofconverters.

Unit-VI Multi-terminal DC Systems: (7Hrs)

Introduction, Configurations and Types of MTDC Systems, Control and Protection of MTDC Systems Configurations and Types of MTDC Systems, Reversal of Power in MTDC System, Comparison between MTDC and AC Interconnections, Philosophy and tools – HVDC system simulation – Modeling of HVDC systems for digital dynamic simulation.

Term Work:

Minimum 8 experiments to be performed based on simulation:

A] MATLAB/SIMULINK/PSCAD/EMBTC or PSPICE may be used for simulation.B]

Compulsory One field visit to HVDC Station.

Text Books:

1) Edward Wilson Kimbark “Direct Current Transmission” Wiley publication Inter science
2) K R Padiyar “HVDC power transmission systems” second edition, New AgeInternational(p)Ltd
3) S. Kamkshaiah and V Kamraju “HVDC transmission” Tata Mc Graw Hill Education Pvt.Ltd,New Delhi.

Reference Books:

1) S. Rao“ EHVAC and HVDC Transmission Engineering and Practice” –Khanna publication,

Sr. No	Sem	Code No.	Subject	Credits
4	VII	PCC-EE414	EHVAC	04

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of this course student should be able to

CO414.1 Understand the role of EHV AC transmission, trends in EHVAC transmission, concept of lightningstrokes to the lines and their mechanism and over voltage in EHV system caused by switching operations along with the power circle diagram

CO414.2 Design EHV AC line parameters as corresponding to power system requirements

CO414.3 Illustrate the concept of distribution of voltage gradient on sub conductors of bundle and effect ofcorona like audible noise and travelling and standing waves at the power frequency

CO414.4 Analyze the differential equations and solutions for standing waves and natural frequencies andresponse of travelling and standing waves to sinusoidal excitation

CO414.5 Analyze compensated devices for voltage control

Syllabus:

Course Code And Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE-414 EHVAC	03	01	--	04	ISE	-	-	--	--	-	-
					MSE	30	12	-	-	-	-
					ESE	70	28	--	--	--	--

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

Section I

Unit I - Introduction to EHVAC Transmission: **(7 Hrs)**

Standard transmission voltages, Engineering aspect and growth of EHVAC Transmission line, trends and preliminaries, power handling capacity and line losses, calculation of line and ground parameters, transient stability limit, and surge impedance loading. Resistance of conductor and power loss, temperature rise and current carrying capacity of conductor, properties of bundled conductors, calculation of inductance and capacitance of bundled conductor, calculation ofsequence inductances and capacitances, line parameters for modes of propagations.

Unit II- Voltage gradients of conductor and corona loss: **(6 Hrs)**

Charge-potential relations for multi-conductor lines, surface voltage gradient on conductor, distribution of voltage gradients on sub conductors of bundle. I 2R and corona loss, corona-loss formulae, charge-voltage diagram and corona loss, attenuation of traveling waves due to corona loss, Audible noise, corona pulses: their generation and properties, limits for radio interfacefields

Unit III- Theory of the Traveling waves and standing waves: **(5Hrs)**

Travelling and standing waves at the power frequency, differential equations and solutions for general case, standing waves and natural frequencies, open ended line: double exponential response and response to sinusoidal Excitation, line energization with trapped charge voltage, reflection and refraction of traveling waves.

Section II

Unit IV- Lightning and lightning protection & Insulation Co-ordinations: **(6 Hrs)**

Lightning strokes to lines, their mechanism, General principle of the lightning protections problems, tower footing resistance, lightning arrestors and protective characteristics, Insulation level, Voltage withstands levels of protected equipment and insulation coordination based on lightning.

Unit V- Over voltage in EHV system caused by switching operations: **(7 Hrs)**

Origin of over-voltages and their types, short circuit current and circuit breaker, recovery voltageand circuit breaker, over-voltages caused by interruption of low inductive and capacitive currents, Ferro-resonance over-voltages, calculation of switching surges- single phase equivalents.

Unit VI- Power frequency voltage control and over voltages : **(5Hrs)**

Generalized constants, no load voltage conditions and charging current, power circle diagramand its use, cascade connection of components: shunt and series compensation, sub-synchronous resonance in

series capacitor compensated lines, static reactive compensating systems (Static VAR)

Texts and references:

1) Rakosh Das Begamudre ,"Extra high voltage AC transmission engineering", NewAgePublication

2) EHV -AC and HVDC transmission system engineering analysis and design: John Wiley&sons.

3) EHV –AC and HVDC Transmission Engineering &Practice : S. Rao, Khanna Publishers, 3rdEdition, 2012

Sr. No	Sem	Code No.	Subject	Credits
5	VII	PCC-EE415	Electrical Generation, Utilization & Traction	04

PSOs:

1) Apply the fundamental knowledge of mathematics, science, electrical engineering to analyze and solve the complex problems in electrical, electronics and allied interdisciplinary areas.
2) Design, develop and implement electrical and electronics and allied interdisciplinary projects to meet the demands of industry and to provide solutions to the current real time problems.

COs:

At the end of the course the students should be able to:

1) CO415.1 Explain about Electrical Utilization and applications and the motors used for electric traction, their control & braking and power supply system used for electric traction.
2) CO415.2 Discuss non-conventional energy sources & different methods of electric heating & welding.
3) CO415.3 Analyze systems of electric traction, speed time curves and mechanics of train movement.

Course Code And Title	Teaching Scheme					Evaluation Scheme					
						Theory (Marks)		Practical(Marks)		POE(Marks)	
	L	T	P	Credit	Scheme	Max.	Min. for Passing	Max.	Min. for passing	Max.	Min. for passing
PCC-EE415EGUT	3	1	--	4	ISE	-	-	--	--	-	-
					MSE	30	12	25	10	-	-
					ESE	70	28	--	--	--	--

ISE: In Semester Evaluation MSE: Mid Semester Evaluation ESE: End Semester Evaluation

Section –I

Unit I: Electrical Energy Generation using Conventional Energy Sources: (8hr)

Electric energy demand, Electric energy growth in India, Power crisis in India. Types of Generation: Diesel &Gas Power Plant: Advantages, Disadvantages, applications of Diesel plant. Gas Turbine plant: Principle of operation, Open cycle, closed cycle plant & Applications of gas plant. Thermal power plant: Main & auxiliary equipment"s in Thermal plant. Hydroelectric Plant: Advantages, disadvantages, & Classifications

of hydro plant. Nuclear Power Plant: Main parts of nuclear plant, advantages & disadvantages of nuclear plant. Co-Generation: Technologies, Industries suitable for Cogeneration.

Unit II: Solar Energy: (8hr)

A) Introduction, Beam & Diffuse solar radiation, Measurement of solar radiation, Derived solar angles, sunrise sunset & day length, sunrise hour angle, solar collectors, storage of solar energy, solar water heaters, distillation, solar still, solar cooker, estimation of average solar radiation

B) Solar Photovoltaic: Introduction, Solar cell characteristics & losses. Emerging solartechnologies, Solar PV modules, Design of PV module, Sizing of Battery, inverter & charge controller.

C) PV module power output, IV curve for PV module, batteries for PV cell, Battery charge controllers, Types of PV systems: Grid tie PV system, Standalone PV system, direct PV system.

Unit III: Wind Energy: (8hr)

Introduction, Principle of wind energy conversion, power duration & velocity duration characteristics of wind, advantages & disadvantages of WECS, Classification of wind mills, basic components of wind mill, aerodynamic forces acting on wind mill blades, Design considerations of horizontal axis & vertical axis wind mill, Wind Data & site selection considerations, Social economic & environmental considerations.

Section –II

Unit-IV: Electric Heating and Welding (8hr)

Classification of electric heating, heating methods, Resistance heating, design of heating element, Arc furnaces, induction heating, Induction furnaces, Dielectric heating, Electric arc welding, welding transformer, Power supply and control of electric welding, Laser beam welding.

Unit-V: Electric traction (8hr)

DC, AC and composite traction systems, main line and suburban systems, Comparison with Diesel-Electric traction, traction equipment‟s, Trolley wire, catenaries, Feeding and distribution systems, negative booster, overhead lines, current collectors, traction substations .

Unit-VI (8hr)

Train movement and Energy consumption: Trapezoidal and quadrilateral speed-time curves, Maximum, average and scheduled speeds, Mechanics of train movement, tractive effort calculation, Power and energy output from driving axles, Specific Energy Output. B) Braking & control of traction motors: Vacuum brake and Air brake systems, regenerative braking, calculation of energy returned during regenerative braking. D.C. series, A.C. series and 3 Phase Induction motors for traction, Brief introduction to rheostatic speed control methods, drumcontroller, Multiple Unit Control, Static control of traction motors. Use of microprocessors for control of traction motors.

Texts and references:

1) Generation of Electrical energy by Dr. B.R. Gupta. S. Chand Publications.
2) Non Conventional& Renewable energy sources by S.S. Thipse Narosa publishing house.
3) Utilization of Electric Power and Electric Traction: J.B. Gupta, 8th Edition
4) Art and science of Utilization of Electric Energy: H. Partab
5) A course in Electrical Power: Soni, Gupta and Bhatnagar
6) Utilization of Electric Energy: Open shaw Taylor