GOVERNMENT COLLEGE OF ENGINEERING, BARGUR
Regulation – 2017

AUTONOMOUS

Curriculum for Part Time – B.E. -EEE
From the Academic Year 2017-2018 onwards

SEMESTER I

SL. No.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	17PTEBS101	Mathematics	BS	3	0	0	3
2.	17PTEBS102	Physics	BS	3	0	0	3
3.	17PTEBS103	Chemistry	BS	3	0	0	3
4.	17PTEPC104	Electric Circuit Analysis	PC	3	0	0	3
PRACTICALS							
5.	17PTEES105	Computer Programming Laboratory	ES	0	0	3	1
			TOTAL	**12**	**0**	**3**	**13**

SEMESTER – II

SL. No.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	17PTEPC201	Measurements and Instrumentation	PC	3	0	0	3
2.	17PTEPC202	Electromagnetic Theory	PC	3	0	0	3
3.	17PTEBS203	Environmental Science and Engineering	BS	3	0	0	3
4.	17PTEPC204	Analog Electronics	PC	3	0	0	3
5.	17PTEPC205	Power Plant Engineering	PC	3	0	0	3
			TOTAL	**15**	**0**	**0**	**15**

SEMESTER – III

SL. No.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	17PTEPC301	DC Machines and Transformers	PC	3	0	0	3
2.	17PTEPC302	Control Systems	PC	3	0	0	3
3.	17PTEPC303	Linear Integrated Circuits and Applications	PC	3	0	0	3
4.	17PTEPC304	Digital Logic Circuits	PC	3	0	0	3
PRACTICALS							
5.	17PTEPC305	Control and Instrumentation Laboratory	PC	0	0	3	1
			TOTAL	**12**	**0**	**3**	**13**

SEMESTER – IV

SL. No.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	17PTEPC401	Microprocessors, Microcontrollers and Applications	PC	3	0	0	3
2.	17PTEPC402	Power Electronics	PC	3	0	0	3
3.	17PTEPC403	Synchronous and Asynchronous Machines	PC	3	0	0	3
4.	17PTEPC404	Transmission and Distribution	PC	3	0	0	3
PRACTICALS							
5.	17PTEPC405	Electrical Machines Laboratory	PC	0	0	3	1
			TOTAL	**12**	**0**	**3**	**13**

SEMESTER – V

SL. No.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	17PTEPC501	Power System Analysis	PC	3	0	0	3
2.	17PTEPC502	High Voltage Engineering	PC	3	0	0	3
3.	17PTEPC503	Electrical Machine Design	PC	3	0	0	3
4.		Professional Elective I	PE	3	0	0	3
PRACTICALS							
5.	17PTEPC505	Microprocessors, Microcontrollers and Applications Laboratory	PC	0	0	3	1
			TOTAL	**12**	**0**	**3**	**13**

SEMESTER – VI

SL. No.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	17PTEPC601	Power System Operation and Control	PC	3	0	0	3
2.	17PTEPC602	Protection and Switchgear	PC	3	0	0	3
3.	17PTEPC603	Professional Ethics	PC	3	0	0	3
4.		Professional Elective II	PE	3	0	0	3
PRACTICALS							
5.	17PTEPC605	Power Electronics Laboratory	PC	0	0	3	1
			TOTAL	**12**	**0**	**3**	**13**

SEMESTER – VII

SL. No.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	17PTEPC701	Energy Utilization, Conservation and Auditing	PC	3	0	0	3
2.		Professional Elective III	PE	3	0	0	3
3.		Professional Elective IV	PE	3	0	0	3
PRACTICALS							
4.	17PTEEE704	Project Work	EEC	0	0	18	6
			TOTAL	**9**	**0**	**6**	**15**

Grand Total Credits: 95

LIST OF PROFESSIONAL ELECTIVES

SL. No.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1.	17PTEPE001	Solid State drives	PE	3	0	0	3
2.	17PTEPE002	Advanced Control System	PE	3	0	0	3
3.	17PTEPE003	Fibre Optics and Laser Instruments	PE	3	0	0	3
4.	17PTEPE004	Biomedical Instrumentation	PE	3	0	0	3
5.	17PTEPE005	Fundamentals of Nanoscience	PE	3	0	0	3
6.	17PTEPE006	Power Quality	PE	3	0	0	3
7.	17PTEPE007	Special Electrical Machines	PE	3	0	0	3
8.	17PTEPE008	Total Quality Management	PE	3	0	0	3
9.	17PTEPE009	Power System Dynamics	PE	3	0	0	3
10.	17PTEPE010	System Identification and Adaptive Control	PE	3	0	0	3
11.	17PTEPE011	Principles of Management	PE	3	0	0	3
12.	17PTEPE012	High Voltage Direct Current Transmission	PE	3	0	0	3
13.	17PTEPE013	Power System Transients	PE	3	0	0	3
14.	17PTEPE014	Micro Electro Mechanical Systems	PE	3	0	0	3
15.	17PTEPE015	Power Electronics for Renewable Energy Systems	PE	3	0	0	3
16.	17PTEPE016	Flexible AC Transmission Systems	PE	3	0	0	3

CREDIT SUMMARY

Sl. No	Subject Area	Credits per Semester							Credits Total	% of Total Credits	Total no. of Subjects
		I	II	III	IV	V	VI	VII			
1	BS	9	3						12	13	3
2	ES	1							1	01	1
3	PC	3	12	13	13	10	10	3	64	67	25
4	PE					3	3	6	12	13	4
5	EEC							6	6	06	1
	Total	13	15	13	13	13	13	15	95	100	34

Semester-I

17PTEBS101	MATHEMATICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Matrix Algebra And Techniques And Using Them In Engineering Applications.
- The Concept Of Infinite Series And Their Convergence So That They Will Be Familiar With Limitations Of Using Infinite Series Approximations For Solutions Arising In Mathematical Modelling.
- Differential And Integral Calculus And Their Applications In Various Engineering Applications.

UNIT I	MATRICES	9

Characteristic equation – Eigen values and Eigenvectors of a real matrix – Properties of eigen values and eigenvectors – Cayley-Hamilton Theorem – Diagonalization of matrices - Reduction of a quadratic form to canonical form by orthogonal transformation.

UNIT II	FUNCTIONS OF SEVERAL VARIABLES	9

Partial derivatives – Homogeneous functions and Euler's theorem – Total derivative – Differentiation of implicit functions – Change of variables – Jacobians – Partial differentiation of implicit functions –Taylor's series for functions of two variables - Maxima and minima of functions of two variables.

UNIT III	ANALYTIC FUNCTION	9

Analytic functions – Necessary and sufficient conditions for analyticity – Properties – Harmonic conjugates – Construction of analytic function – Conformal Mapping – Mapping by functions w = a + z, az, 1/z - Bilinear transformation.

UNIT IV	COMPLEX INTEGRATION	9

Line Integral – Cauchy's theorem and integral formula – Taylor's and Laurent's Series – Singularities– Residues – Residue theorem – Application of Residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour with no pole on real axis.

UNIT V	LAPLACE TRANSFORM	9

Existence conditions – Transforms of elementary functions – Basic properties – Transforms of derivatives and integrals –Inverse transforms – Convolution theorem – Transform of periodic functions– Application to solution of linear ordinary differential equations with constant coefficients.

TOTAL : 45 PERIODS

OUTCOMES	
1.	Use matrix algebra techniques for practical applications and understand theimportance of functions of several variables and their applications in engineering.
2.	Understand the standard techniques of complex variable theory and apply them with confidence in areas such as heat conduction, elasticity, fluid dynamics and the flow of electric current.
3.	Solve problems on Laplace transforms and use the transform techniques to find solutions to differential equations.

TEXT BOOKS:	
1.	Grewal. B.S, "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, Delhi, 2012.
2.	Ramana, B.V., "Higher Engineering Mathematics" Tata McGraw Hill Publishing Company, 2008

REFERENCES:	
1.	*Dass, H.K., and Er. Rajnish Verma," Higher Engineering Mathematics", S.Chand Private Ltd., 2011.*
2.	*Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2012*
3.	*Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012.*
4.	*Sivarama Krishna Das P. and Rukmangadachari E., "Engineering Mathematics", Volume I, Second Edition, PEARSON Publishing, 2011.*
5.	*Veerarajan, T.,"Engineering Mathematics(For first year)", Tata McGraw-Hill Pub. Pvt. Ltd., New Delhi, 2007.*

COURSE ARTICULATION MATRIX

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1										
CO2										
CO3										
CO3										
CO4										
CO5										

L-Low, M-Moderate (Medium), H-High

17PTEBS102	PHYSICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To develop knowledge on properties of solids.
- To use the principles of lasers, its types and its application.
- To make students to understand about fiber optics and its applications.
- To develop knowledge on thermal properties of materials
- To apply principles of quantum physics in engineering field.

UNIT I ELECTRICAL PROPERTIES OF MATERIALS 9

Conductors – Classification of conducting materials – Ohm's Law – Electrical conductivity – Relation between current density, drift velocity and mobility – Classical free electron theory of metals – Expression for electrical conductivity of a metal – Thermal conductivity – Expression for thermal conductivity of a metal – Wiedemann – Franz law – success and failures of classical free electron theory –Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states.

UNIT II SEMICONDUCTOR PHYSICS 9

Introduction – Intrinsic semiconductor – Energy band diagram – Direct and indirect semiconductors – Carrier concentration in intrinsic semiconductors (derivation) – Extrinsic semiconductors – Carrier concentration in n-type & p-type semiconductors –Hall effect – Determination of Hall coefficient (Theory) – Application of Hall effect.

UNIT III MAGNETIC PROPERTIES OF MATERIALS 9

Magnetization – Magnetic flux – Magnetic flux density – Intensity of Magnetisation – Magnetic field intensity – magnetic permeability – magnetic susceptibility – Magnetic field and induction – Types of magnetic materials – Microscopic classification of magnetic materials – Ferromagnetism : origin and exchange interaction – Domain theory- Hard and soft magnetic materials – Magnetic storage devices – Hard disk.

UNIT IV DIELECTRIC PROPERTIES OF MATERIALS 9

General properties of Dielectric materials – Electrical susceptibility – Dielectric constant – Electronic, ionic, orientational and space-charge polarization – Frequency and Temperature dependence of Polarisation– Internal field – Claussius – Mosotti relation (derivation) – Dielectric breakdown – Dielectric loses – Use of dielectric materials (capacitor and transformer) - Ferro electricity and its applications.

UNIT V MODERN ENGINEERING MATERIALS 9

Metallic glasses – Properties of metallic glasses – Shape memory alloys (SMA) – Preparation, properties and applications of Shape memory alloys (SMA) – Characteristics of Shape memory alloys – Characteristics, properties of Ni-Ti alloy, application, advantages and disadvantages of shape memory alloys (SMA) – Nanomaterials – Different forms of

nanomaterials – Preparations –Pulsed Laser Deposition, Chemical Vapour Deposition and Applications.	
	TOTAL : 45 PERIODS
OUTCOMES	
1.	To explore knowledge about free electron theory and density of states of conducting materials with related laws
2.	Students are able to compare intrinsic and extrinsic semiconductor, density of electrons and holes calculation, Hall effect with applications and basic semiconductor devices
3.	To learnt comparatively about different type of magnetic materials, superconducting materials and apply in their engineering field.
4.	To attain the functional knowledge of different types of dielectric materials, polarization mechanism and their qualitative engineering applications.
5.	To know more about preparation of modern engineering materials and materials suitability for their own engineering field
TEXT BOOKS:	
1.	P. Mani, "Engineering physics", Dhanam Publications, 2011.
2.	G. Senthilkumar, "Engineering physics", VRB Publishers.
3.	A.Marikani, "Engineering Physics" PHI Learning Pvt., India 2009.
4.	Wahen M. A. "Solid state physics: Structure and properties of materials"Narosa publishing house, 2009
REFERENCES	
1.	*R.K. Gaur and S.C. Gupta, "Engineering physics", Dhanpat Rai publications, New Delhi 2003.*
2.	*M.N.Avadhanulu and P. G. Kshirsagar, "A text book of engineering physics" S.Chand and Company,Ltd , New Delhi 2005.*
3.	*K. Rajagopal, "Engineering Physics", PHI, New Delhi, 201.*
4.	*M. Arumugam, "Engineering physics",Anuradha publishers..*

17PTEBS103	CHEMISTRY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make students conversant with water parameters, boilers, need for water treatment and its merits and demerits.
- Students ought to be aware of fundamental principles behind different electrochemical reactions, corrosion of materials and methods to prevent corrosion.
- To learn the chemistry behind polymers, synthesis, merits, demerits and its applications in various field.
- To acquire basic knowledge in renewable, non renewable and alternate energy resources and the chemical reactions involved in cell, batteries and its applications.
- To learn the working principle of various spectroscopy and its applications.
- To acquire basic knowledge in Nano materials, synthesis, properties and uses.

UNIT I WATER TECHNOLOGY 9

Characteristics – alkalinity and its significance – hardness - types and estimation by EDTA method – specifications of drinking water (BIS and WHO standards) – potable water treatment – boiler feed water - requirements – disadvantages of using hard water in boilers – water treatment – Internal treatment – external treatment – zeolite method - Demineralization process – desalination – reverse osmosis.

UNIT II ELECTROCHEMISTRY AND CORROSION 9

Electrochemistry: Electrochemical cells – reversible and irreversible cells – EMF – measurement of EMF – single electrode potential – Nernst equation (Problems) – reference electrode – standard hydrogen electrode and calomel electrode – ion selective electrode – glass electrode and measurement of pH – electrochemical series and its applications.

Corrosion: Corrosion – Pilling Bedworth rule - dry corrosion - electrochemical corrosion and its mechanism – types (galvanic, pitting, differential aeration) – factors influencing corrosion – corrosion control methods - sacrificial anode method – impressed current method – corrosion inhibitors – protective coatings – paints – constituents – functions

UNIT III POLYMERS AND COMPOSITES 9

Polymers: Definition – classification – functionality – polymerization – degree of polymerization – types (addition, condensation, copolymerization) – mechanism (free radical) – plastics – thermoplastics and thermosetting plastics – preparation, properties and uses of individual polymers (PVC, TEFLON, Nylon-6,6, Nylon-6, PET, epoxy resin) – rubber - vulcanization of rubber – applications

Composites: definition – types polymer matrix composites – Fibre Reinforced Polymers – applications – advanced composite materials – physical and chemical properties – applications.

UNIT IV ENERGY SOURCES AND STORAGE DEVICES 9

Renewable and non-renewable energy resources -Nuclear energy – fission fusion reactions – light water nuclear reactor for power generation – breeder reactor – solar energy conversion – solar cells – wind energy – batteries: alkaline batteries – lead –acid, Ni- Cd ,and Li-ion batteries – fuel cells – principles and applications – advantages and disadvantages.		
UNIT V	**NANOCHEMISTRY**	**9**
Nanomaterials: Introduction to nanotechnology in electronics – nano materials – fullerernes carbon nano tubes **–** nano wires – special properties - synthesis of nano materials – top down and bottom up approach – applications of nano materials in electrical and electronic appliances (Semiconductors, LED & OLED) – electrical appliances – medicines.		
		TOTAL : 45 PERIODS

COURSE OUTCOMES

At the end of the course students should be able to

1.	Analyze water borne problems faced in boilers, need for water treatment and various methods and techniques for treating hard water.
2.	Understand advance polymer materials and its applications in engineering field.
3.	Understand the mechanism behind various types of electrochemical reactions which in turn helps in understanding the causes for corrosion and prevention methods.
4	Acquire Knowledge about energy conversion and chemical reaction taking place in nuclear, solar, wind energy, Batteries, fuel cells and its applications, merits and demerits.
5.	Acquire in-depth knowledge on various nano materials and its applications in electrical devices. Students get basic knowledge on advanced analytical techniques.

TEXT BOOKS:

1.	Vairam S, Kalyani P and SubaRamesh.,"Engineering Chemistry".,WileIndiaPvtLtd.,New Delhi., 2011
2.	Dara S.S,Umare"Engineering Chemistry", S. Chand & Company Ltd., New Delhi , 2010

REFERENCES:

1.	*Pahari A and Chauhan B., "Engineering Chemistry"., Firewall Media., New Delhi., 2010.*
2.	*Rao, C. N. R.; Govindaraj, A. "Nanotubes and Nanowires" United Kingdom: Royal Society of Chemistry, 2005*
3.	*Advanced Polymeric Materials: From Macro- to Nano-Length Scales edited by Sabu Thomas, Nandakumar Kalarikkal, MaciejJaroszewski, Josmine P. Jose; Apple Academic press, Canada, 2016*
4.	*Jain and jain , 16theditin, "Engineering Chemistry" DhanpatRqai Publishing Co.*

17PTEPC104	ELECTRIC CIRCUIT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce electric circuits and its analysis
- To impart knowledge on solving circuits using network theorems
- To introduce the phenomenon of resonance in coupled circuits
- To educate on obtaining the transient response of circuits
- To Phasor diagrams and analysis of three phase circuits

UNIT I	BASICCIRCUITSANALYSIS	9

Ohm's Law–Kirchhoff'slaws–DCandACCircuits–Resistorsinseriesandparallelcircuits – Mesh current and Node voltage analysis for D.C and A.C.circuits–Phasor Diagram – Power,Power Factor and Energy.

UNIT II	NETWORK REDUCTION AND NETWORK THEOREMS FOR DC AND AC CIRCUITS	9

Network reduction: voltage and current division, source transformation– star delta conversion. Thevenin and Norton Theorem – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem.

UNIT III	RESONANCEANDCOUPLEDCIRCUITS	9

Series and parallel resonance–their frequency response–Quality factor and Band width–Coupled Circuits-Self and mutual inductance–Coefficient of coupling–Analysis of coupled circuits-Tuned circuits–Single and double tuned circuits.

UNIT IV	CIRCUIT TRANSIENTS	9

Laplace Transformations-Advantages-Laplace transformation of some functions-RL transient-Decay of current in RL Circuits-RC Transient: Decay of Current in RC Circuits-RLC Transient: Over-damped, Critically Damped and Under damped-AC Transients-RL, RC and RLC Circuits-Natural Frequency and Damping Ratio.

UNIT V	THREEPHASECIRCUITS	9

Comparison between single phase and polyphase systems-Three phase balanced/unbalanced sources– analysis of three phase 3-wire and 4-wire circuits with star and delta connection-balanced and unbalanced loads-– phasor diagram of voltages and currents–power and power factor measurements in three phase circuits.

TOTAL :45 PERIODS

OUTCOMES:

1.	Explain circuit behaviour using ohm's law and Kirchhoff laws, hence solve the circuits using mesh and nodal analysis
2.	State various circuit laws and theorems and perform the circuit analysis to prove the theorems.
3.	Explain the behaviour of resonance and magnetically coupled circuits.
4.	Explain AC circuits using phasor techniques under steady state and transient conditions for any first order and second order systems using R, L, and C Circuits.

TEXT BOOKS:	
1.	Arumugam M and Prem Kumar, "Electric Circuit Theory", Khanna Publishers, New Delhi,2006
2.	SudhakarAandShyamMohanSP,"CircuitsandNetworkAnalysisandSynthesis",TataMcGraw Hill,2015.
3.	CharlesK.Alexander, MathewN.O.Sadiku,"FundamentalsofElectricCircuits",Second Edition, McGrawHill,2013.
REFERENCES:	
1.	*Joseph A. Edminister, Mahmood Nahri, "Electric circuits", Schaum'sseries, TataMcGraw-Hill,NewDelhi,2014.*
2.	*Paranjothi SR, "Electric Circuits Analysis," New Age International Ltd., New Delhi, 1996.*
3.	*Ashfaq Husain and Harroon Ashfaq, "Fundamentals of Electrical Engineering", Dhanpath Rai & Sons, New Delhi, 2016*
4.	*William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", Tata McGraw Hill publishers, 6 edition, New Delhi, 2003.*

17PTEES105	COMPUTER PROGRAMMING LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES:

- Be familiar with the use of Unix OS.
- Be exposed to presentation and visualization tools.
- Be exposed to problem solving techniques and flow charts.
- Be familiar with programming in C.
- Learn to use Arrays, strings, functions, structures and unions.

LISTOFEXPERIMENTS:

UNIX Commands

1. Study of UNIX OS.
2. Basic UNIX commands.
3. Directory commands and Process Management commands.
4. Study of vi Editor

Shell Programming

Simple Shell Programming

5. a) Program for getting and displaying the academic and personal details.
   b) Program to demonstrate the Arithmetic Operations.

Conditional statements

6. a) Program to find whether a number is odd or even
   b) Program to find whether a number is Positive (or) Negative
   c) Program to find the biggest number among three numbers
   d) Program to perform Arithmetic Operations using Switch Case
   e) Program to find the area of Circle, Square , Rectangle ,Triangle.

Testing and loops

7. a) Program to print the Fibonacci serious
   b) Program to find whether a number is a Armstrong number
   c) Program to find the Sum of even numbers up to N
   d) Program to print the various Combinations of 123
   e) Program to find the n^{th} power of given number

C Programming

8. a) Program to check whether a sting is a Palindrome
   b) Program to perform the Concatenation of two strings
9. Program to find the biggest number among n numbers using functions.
10. Program to swap of two numbers using pointers .
11. Program to read contents of a File and to Print the same .
12. Program to demonstrate Dynamic memory allocation.

TOTAL : 45 PERIODS

OUTCOMES:	
1.	An ability todo simple shell and C programming.

Semester II

17PTEPC201	MEASUREMENTS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:	
•	To introduce the basic functional elements of instrumentation
•	To introduce the fundamentals of electrical instruments
•	To educate on the comparison between various measurement techniques
•	To introduce the fundamentals of electronic instruments
•	To introduce various transducers and the data acquisition systems

UNIT I	INTRODUCTION	9

Types of measurements, instrument classification, Elements of generalized measurement system, input output configuration of measuring instruments, selection of an instruments– Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration.

UNIT II	ELECTRICAL INSTRUMENTS	9

Principle and working of Moving coil, moving iron and dynamometer type Instruments.– Single and three phase wattmeters-Single and three phase energy meters – Magnetic measurements: Determination of B-H curve and measurements of iron loss – Instrument transformers – Theory and construction of current and potential transformers, transformation ratio and phase angle errors and their minimization - measurement of frequency and phase.

UNIT III	POTENTIOMETERS AND BRIDGES	9

D.C potentiometer-Laboratory type, A.C potentiometers-Polar and co-ordinate type, Measurement of low and medium resistance- Kelvin's Double bridge, Wheatstone bridge. Measurement of self-inductance- Maxwell's bridges and Hay's bridge. Measurement of mutual inductance - Anderson's bridge-Low and high voltage Schering bridges- transformer ratio bridges, self-balancing bridges. Sources of error in AC bridges and their minimization. Measurement of high resistance- loss of charge method and Mega ohm bridge method.

UNIT IV	ELECTRONIC INSTRUMENTS	9

Digital voltmeters, ammeters, multimeters, DMM with auto ranging and self-diagnostic features-Signal Generators- Distortion meter- Q-meters-Digital R-L-C meters-Spectrum analyzer-Wave analyzer- digital plotters and printers, CRT display, digital CRO, LED and LCD display, Sampling and Digital storage oscilloscope.

UNIT V	TRANSDUCERS AND SIGNAL CONDITIONING	9

Transducers – selection criteria ,Resistive Transducers-Potentiometers, strain gauges, Resistance Thermometer, Thermistors, inductive transducers- LVDT, capacitive transducers-based on change in distance between plates– Piezoelectric, thermocouple, Hall effect, optical and digital transducers, ultrasonic transducers – Instrumentation amplifiers, A/D and D/A conversion, S/H and

multiplexers-Smart sensors.	
	TOTAL : 45PERIODS
OUTCOMES:	
1.	Analyse the characteristics of generalized electrical measurements and its errors.
2.	Determine various parameters using various type of analog instruments
3.	Determine unknown Resistance, inductance and capacitance values using bridge circuits.
4.	Explain the measurements of various parameters using various type of digital instruments
5.	Analyse the performance of various type of transducers, and signal conversion systems.
TEXT BOOKS:	
1.	A.K.Sawhney,'ACourse in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co,2004.
2.	J.B.Gupta,'A Coursein Electronic and Electrical Measurements',S.K.Kataria & Sons, Delhi,2003.
3.	Doebelin E.O.and Manik D.N.,Measurement Systems–Applications and Design, Special Indian Edition, Tata McGraw Hill Education Pvt.Ltd.,2007.
REFERNCES:	
1	*H.S.Kalsi, 'Electronic Instrumentation', TataMcGrawHill, IIEdition2004*
2	*D.V.S.Moorthy,'Transducers and Instrumentation', Prentice Hall of India PvtLtd, 2007.*
3	*A.J.Bouwens,'Digital Instrumentation',TataMcGrawHill,1997.*
4	*Martin Reissland,'Electrical Measurements', New Age International (P) Ltd., Delhi, 2001.*
5.	*Alan.S.Morris, Principles of Measurements and Instrumentation, 2nd Edition, Prentice Hall of India,2003.*

17PTEPC202	ELECTRO MAGNETIC THEORY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the basic mathematical concepts related to electromagnetic vector fields
- To impart knowledge on the concepts of electrostatics, electrical potential, energy density and their applications.
- To impart knowledge on the concepts of magneto statics, magnetic flux density, scalar and vector potential and its applications.
- To impart knowledge on the concepts of Faraday's law, induced emf and Maxwell's equations
- To impart knowledge on the concepts of Concepts of electromagnetic waves and Pointing vector.

UNIT I	INTRODUCTION	9

Sources and effects of electromagnetic fields – Vector fields – Different co-ordinate systems-vector calculus – Gradient, Divergence and Curl - Divergence theorem – Stoke's theorem.

UNIT II	ELECTROSTATICS	9

Coulomb's Law – Electric field intensity – Field due to point and continuous charges – Gauss's law and application – Electric potential – Electric field and equi potential plots – Electric field in free space, conductors, dielectric - Dielectric polarization – Dielectric strength - Electric field in multiple dielectrics – Boundary conditions, Poisson's and Laplace's equations – Capacitance-Energy density.

UNIT III	MAGNETOSTATICS	9

Lorentz Law of force, magnetic field intensity – Biot – Savarts Law - Ampere's Law – Magnetic field due to straight conductors, circular loop, infinite sheet of current – Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization – Magnetic field in multiple media –Boundary conditions – Scalar and vector potential – Magnetic force – Torque – Inductance – Energydensity – Magnetic circuits.

UNIT IV	ELECTRODYNAMIC FIELDS	9

Faraday's laws – induced emf – Transformer and motional EMF – Forces and Energy in quasi stationary Electromagnetic Fields - Maxwell's equations (differential and integral forms) – Displacement current – Relation between field theory and circuit theory.

UNIT V	ELECTROMAGNETIC WAVES	9

Electromagnetic wave equations – Wave parameters; velocity, intrinsic impedance, propagation constant– Waves in free space, lossy and lossless dielectrics , conductors – skin depth, Poynting vector – Transmission lines – Line equations– Input impedances – Standing wave ratio and power.

	TOTAL : 45 PERIODS
OUTCOMES:	
1.	Describe the coordinate systems, vector calculus and theorems to electric and magnetic fields.
2.	Compare the nature, characteristics, properties and applications of Electric and Magnetic fields with the help of fundamental laws of fields.
3.	Explain voltage, and current using electric fields and Develop resistance, capacitance and inductance of a given electrical component.
4.	Relate electric and magnetic fields with help of Faraday's Law and Maxwell's Equation, and, their applications to electrical machines
5.	Explain Electromagnetic Wave propagation, Poynting Vector and Poynting Theorem and Appreciate the significance of electric and magnetic fields in electrical engineering
TEXT BOOKS:	
1.	Mathew N. O. Sadiku, "Elements of Electromagnetics", Oxford University press Inc. India Edition, 2014.
2.	Joseph. A. Edminister, "Theory and Problems of Electromagnetics", 2nd Edition, Schaum Series, Tata McGraw Hill, 1993.
3.	K.A.Gangadhar, P.M.Ramanthan, 'Electromagnetic Field Theory (including Antennas and wave propagation)', 16th Edition, Khanna Publications, 2008.
4.	S.P.Seth, "Elements of Electromagnetic Fields", Dhanpath Rai & Sons, New Delhi, 2001.
REFERNCES:	
1.	*Ashutosh Pramanik, "Electromagnetism – Theory and Applications", Prentice-Hall of India Private Limited, New Delhi, 2008.*
2.	*William. H. Hayt, "Engineering Electromagnetics", Tata McGraw Hill, 2011*
3.	*Kraus and Fleish, "Electromagnetics with Applications", McGraw Hill International Editions, 5th Edition, 1999.*
4.	*Bhag Singh Guru and Hüseyin R.Hiziroglu "Electromagnetic field theory Fundamentals", CambridgeUniversityPress;Second Revised Edition,2009.*

17PTEBS203	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	C
		3	0	0	1

OBJECTIVES:

- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I	ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY	12

Definition, scope and importance of Risk and hazards; Chemical hazards, Physical hazards, Biological hazards in the environment – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers-Oxygen cycle and Nitrogen cycle – energy flow in the ecosystem – ecological succession processes – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeo graphical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – 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. Field study of common plants, insects, birds.

Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II	ENVIRONMENTAL POLLUTION & HEALTH RISK	9

Definition – causes, effects and control measures of: (a) Air Pollution: Causes, effects and prevention (b) Water pollution: Causes, effects and prevention (d) Marine pollution (f) Thermal pollution pollution - soil waste management: causes, effects and control measures of municipal solid wastes – case studies

Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III	NATURAL RESOURCES	12
Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and overutilization of surface and ground water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Energy Conversion processes – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. **Field study of local area to document environmental assets – river / forest / grassland / hill**		
UNIT IV	**SOCIAL ISSUES AND THE ENVIRONMENT**	**7**
From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization environmental ethics: Issues and possible solutions – 12 Principles of green chemistry-wasteland reclamation – consumerism and waste products – environment production act – Air act – Water act – Wildlife protection act – Forest conservation act – The Biomedical Waste (Management and Handling) Rules; 1998 and amendments- scheme of labelling of environmentally friendly products (Ecomark). - Central and state pollution control boards-disaster management: floods, earthquake, cyclone and landslides. Public awareness.		
UNIT V	**HUMAN POPULATION AND THE ENVIRONMENT**	**6**
Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare –Environmental impact analysis (EIA)- -GIS-remote sensing-role of information technology in environment and human health – Case studies.		
		TOTAL : 45 PERIODS

COURSE OUTCOMES

At the end of the course students should be able to

1.	Apply the knowledge of environmental science in identifying, to formulate and to solve the environmental problems.
2.	Create awareness about structure and function of various ecosystems and natural resources.
3.	Understand the ignorance and incomplete knowledge will lead to misconceptions.
4.	Analyse the reason behind serious environmental disasters.
5.	Acquire knowledge about important environmental laws.
6.	Acquire in-depth knowledge on population explosion and role of IT in environmental management.

TEXT BOOKS:

1.	Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
2.	Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.

REFERENCES:

1	*R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.*
2	*Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.*
3	*Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD, New Delhi,2007.*
4	*Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press 2005.*

17PTEPC204	ANALOG ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the PN diode and its applications
- To study the operation and characteristics of BJT AND FETS
- To study the biasing of BJT and BJT based amplifiers
- To impart knowledge on feedback amplifiers and oscillators
- To impart knowledge on applications of diode circuits and waveform generators

UNIT I	PN DIODE AND ITS APPLICATIONS	9

PN junction diode - VI characteristics – Resistance - temperature effects – Drift and diffusion currents – Rectifiers: HW, FW, Bridge Rectifiers, filters - Zener diode – Characteristics - LED – Regulators (series and shunt) - Introduction to Switched mode power supply (Quantitative treatment only).

UNIT II	BJT AND FETS	9

Bipolar junction transistor – Construction – Input and output characteristics – CE, CB and CC configurations – hybrid model – Analytical expressions - JFET – VI characteristics, Pinch off Voltage– small signal model - MOSFET - Characteristics – enhancement and depletion mode.

UNIT III	BIASING AND AMPLIFIERS	9

Need for biasing - Different types of biasing circuits – BJT-FET-Small signal analysis-Classification of amplifiers -CE CB amplifier - frequency response - Class A, B, AB, C and D -RC and transformer coupled power amplifiers - Class B complementary- symmetry, push-pull power Amplifiers-Darlington connection.

UNIT IV	FEEDBACK AMPLIFIERS AND OSCILLATORS	9

Differential amplifiers: Common Mode and Differential Mode - CMRR – feedback amplifiers - Voltage / current, series / shunt feedback –condition for oscillation - oscillators – LC, RC, crystal oscillators.

UNIT V	PULSE CIRCUITS	9

RC wave shaping circuits – Diode clampers and clippers – Monostable, Astable and Bistable Multivibrators – Schmitt triggers – UJT based saw tooth oscillators.

TOTAL : 45 PERIODS

OUTCOMES:

1. Explain the characteristics and applications of electronic devices such as diode, special diodes, BJTs, and MOSFETs.
2. Compare various biasing methods and circuits for the BJT and MOSFET amplifiers

3.	Explain the characteristics and applications of feedback amplifiers, pulse circuits and oscillators.
TEXT BOOKS:	
1.	Paynter, "Introductory electronic devices and circuits", PHI, 2006.
2.	David Bell, "Electronic Devices and Circuits", PHI, 2007.
3.	RobertL.Boylestad,"ElectronicDevicesandCircuittheory",2002.
REFERNCES:	
1.	*Theodre F. Boghert, "Electronic Devices & Circuits" Pearson Education, 6thEdition, 2003.*
2.	*Rashid, "Microelectronic circuits", Thomson Publication, 1999.*
3.	*Singh. B.P and Rekha Singh, "Electronic Devices and Integrated Circuits", Pearson Education, 2006.*
4.	*Salivahanan. S, Suresh Kumar. N and Vallavaraj. A, "Electronic Devices and circuits", Tata McGraw Hill, 2003.*

17PTEPC205	POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the construction, operation and characteristics of thermal power plants.
- To study the construction, operation and characteristics of diesel, gas turbine and combined cycle power plants.
- To study the construction, operation and characteristics of various nuclear reactors power plants.
- To study the construction, operation and characteristics of various renewable energy based power plants and energy storage systems.
- To impart knowledge on various economical and environmental issues of various power plants.

UNIT I	COAL BASED THERMAL POWER PLANTS	10

Rankine cycle, Layout of modern coal power plant, Boilers, Turbines, Condensers, Economisers, Super heaters, Reheaters, Subsystems of thermal power plants – Coal and ash handling, ESP Draught system, Feed water treatment, Deaerator. Efficiencies in a steam power plant, Cogeneration systems.

UNIT II	DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS	8

Otto and Diesel Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

UNIT III	NUCLEAR POWER PLANTS	7

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

UNIT IV	POWER FROM RENEWABLE ENERGY	10

Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, *Solar* Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

UNIT V	ENERGY STORAGE, ECONOMICS AND ENVIRONMENTAL ISSUES OF POWER PLANTS	10

Energy Storage: Pumped Hydro, Compressed Air Energy Storage, Flywheel energy storage, Superconducting Magnetic Energy Storage, Super Capacitor Energy Storage, Thermal Energy Storage, Hydrogen Energy Storage - Comparison of site selection criteria, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

	TOTAL : 45 PERIODS
OUTCOMES:	
1.	Explain the construction, operation and characteristics of various conventional power plants such as thermal, diesel, gas and nuclear power plants.
2.	Explain the construction, operation and characteristics of various renewable energy based power plants and energy storage systems.
3.	Explain various economical and environmental issues of various power plants.
TEXT BOOKS:	
1.	P.K. Nag, Power Plant Engineering, Tata McGraw – Hill Publishing Company Ltd., Third Edition, 2008.
2.	M.M. El-Wakil, Power Plant Technology, Tata McGraw-Hill Publishing Company Ltd., 2010.
3.	Black & Veatch, Springer, Power Plant Engineering, 1996.
REFERENCES:	
1.	*Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, Standard Handbook of Power Plant Engineering, Second Edition, McGraw – Hill, 1998.*
2.	*Godfrey Boyle, Renewable energy, Open University, Oxford University Press in association with the Open University, 2004.*

Semester-III

17PTEPC301	DC MACHINES AND TRANSFORMERS	L	T	P	C
		3	0	0	3

OBJECTIVES :

- To expose the students to the operation of various D.C. generators and give them experimental skill.
- To expose the students to the operation of various D.C. motors and give them experimental skill.
- To expose the students to the operation transformers and give them experimental skill to find the efficiency , losses and to draw the equivalent circuit

UNIT I	BASIC CONCEPTS OF ROTATING MACHINES	9

Magnetic Circuits - Principles of electromechanical energy conversion – Single and multiple excited systems – concept of co-energy– Generated voltage – Torque in DC machine.

UNIT II	DC GENERATORS	9

Constructional details – emf equation – Methods of excitation – Self and separately excited generators – Characteristics of series, shunt and compound generators – Armature reaction and commutation – Parallel operation of DC shunt and compound generators.

UNIT III	DC MOTORS	9

Principle of operation – Back emf and torque equation – Characteristics of series, shunt and compound motors – Starting of DC motors – Types of starters – Speed control of DC series and shunt motors.

UNIT IV	TRANSFORMERS	9

Constructional details of core and shell type transformers – Types of windings – Principle of operation – emf equation – Transformation ratio – Transformer on no-load – Parameters referred to HV / LV windings – Equivalent circuit – Transformer on load – Regulation – Parallel operation of single phase transformers – Auto transformer – Three phase transformers – Vector group.

UNIT V	TESTING OF DC MACHINES AND TRANSFORMERS	9

Losses and efficiency in DC machines and transformers – Condition for maximum efficiency – Testing of DC machines – Brake test, Swinburne's test, Retardation test and Hopkinson's test – Testing of transformers – Polarity test, load test, open circuit and short circuit tests – All day efficiency.

TOTAL : 45PERIODS

OUTCOMES:

1.	Explain the concept of magnetic circuits and electromechanical energy theory.
2.	Explain the construction, operation and characteristics of Dc Generators and Motors
3.	Explain the construction, operation and characteristics of Transformers
4.	Determine the losses and efficiency in dc machines and transformers by conducting various tests.

TEXT BOOKS:

1.	Fitzgerald A.E. Kingsly C., Umans S.D., 'Electrical Machinery' 6th edition, McGraw Hill International Edition, New York, 2002.
2.	Kothari D.P. and Nagrath I.J , "ElectricMachines", Tata McGraw Hill, Fourth Ed., 2011.
3.	P. C. Krause, O. Wasynczuk and S. D. Sudhoff, "Analysis of electric machinery," IEEE Press, 1995.
REFERENCES :	
1.	*D.P.Kothari, 'Electrical Machines.' 3rd edition, TMH, New Delhi 2004.*
2.	*P.C.Sen, "Principles of Electrical Machines and Power Electronics", John-Wiley &Sons,Newyork.*
3.	*Cotton H 'Advanced Electrical Technology', CBS Publishers and Distributors, 1967.*
4.	*P.S.Bimbhra,'Electrical Machinery',KhannaPublishers,2003.*
5.	*Fitzgerald A.E., Kingsly C. and Kusko.A., "Electric Machinery", Tata McGraw Hill, 2007.*

17PTEPC302	CONTROL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES :

- To understand the use of transfer function models for analysis physical systems and introduce the control system components.
- To provide adequate knowledge in the time response of systems and steady state error analysis.
- To accord basic knowledge in obtaining the open loop and closed–loop frequency responses of systems.
- To introduce stability analysis and design of compensators.
- To introduce state variable representation of physical systems and study the effect of state feedback

UNIT I	MATHEMATICAL MODELING OF SYSTEMS	9

Basic elements in control systems – Open and closed loop systems – Electrical analogy of mechanical and thermal systems – Transfer function – Synchros – AC and DC servomotors – Block diagram reduction techniques – Signal flow graphs.

UNIT II	TIME RESPONSE	9

Test input signals – Time domain specifications – Type and order – I and II order system response – Generalized Error coefficients –Steady state error – PID Controllers –Performance indices – Root locus construction.

UNIT III	FREQUENCY RESPONSE	9

Frequency response –Frequency domain specifications – Correlation between time and frequency response – Bode plot – Polar plot – Determination of closed loop response from open loop response.

UNIT IV	STABILITY AND COMPENSATOR DESIGN	9

Concept of Stability – Routh-Hurwitz stability criterion - Nyquist stability criterion –Lag, lead and lag-lead networks – Lag, lead and lag-lead compensator design using bode plots – Lag, lead and lag-lead compensator design using Root Locus.

UNIT V	STATE VARIABLE ANALYSIS	9

Concept of state variables for linear time invariant Systems – State models from transfer function –State transition matrix - Solution of state equation – Concepts of controllability and observability.

TOTAL : 45 PERIODS

OUTCOMES:

1.	Determine the transfer function of complex systems using blog reduction and signal flow graph techniques and also draw the analogues electrical circuits for non-electrical systems
2.	Analyse the time and frequency response of various order systems using mathematical techniques
3.	Analyse the stability of closed loop systems
4.	Design the series compensators to achieve required specifications

5.	Analyse the system performance using state variable model technique.
TEXT BOOKS:	
1.	Nagrath J. and Gopal M., Control Systems Engineering, Tata McGraw-Hill Education Private Limited, Reprint, 2010.
2.	Gopal M., "Control Systems, Principles and Design", 4th Edition, Tata McGraw Hill, New Delhi, 2012.
3.	S.K.Bhattacharya, Control SystemEngineering,3rd Edition,Pearson,2013.
REFERNCES:	
1.	*Arthur, G.O.Mutambara, Design and Analysis of Control; Systems, CRC Press, 2009.*
2.	*Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Pearson Prentice Hall, 2012.*
3.	*Benjamin C. Kuo, Automatic Control systems, 7th Edition, PHI, 2010.*

17PTEPC303	LINEAR INTEGRATED CIRCUITS AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the IC fabrication procedure.
- To study characteristics; realize circuits; design for signal analysis using Op-amp ICs.
- To study the applications of Op-amp.
- To study internal functional blocks and the applications of special ICs like Timers, PLL, circuits, regulator Circuits, ADCs, Opto ICs.

UNIT I IC FABRICATION 9

IC classification - fundamental of monolithic IC technology, epitaxial growth, masking and etching, diffusion of impurities - Realization of monolithic ICs and packaging - Fabrication of diodes, capacitance, resistance and FETs.

UNIT II CHARACTERISTICS OF OP-AMP 9

Ideal OP-AMP characteristics, DC characteristics, AC characteristics - offset voltage and current -differential amplifier - frequency response of OP-AMP - Basic applications of OP-AMP – summer, Differentiator and integrator.

UNIT III APPLICATIONS OF OP-AMP 9

Instrumentation amplifier - first and second order active filters - V/I & I/V converters - comparators, Multivibrators - clippers, clampers, peak detector, S/H circuit, D/A converter - R-2R ladder and weighted resistor types - A/D converter -Dual slope, successive approximation and flash types.

UNIT IV SPECIAL ICs 9

Timer: Introduction to 555 timers and its functional diagram, Monostable, Astable and Schmitt Trigger applications - Voltage Controlled Oscillator: Operation and Applications using IC 566 - Phase Locked Loops: Introduction, Principles, Block Schematic and Description of IC 565, Applications of PLL: Frequency multiplication and frequency translation.

UNIT V APPLICATION ICs 9

IC voltage regulators - LM317, 723 regulators, switching regulator, LM2575, LM 380 power Amplifier, ICL 8038 function generator IC, isolation amplifiers, opto coupler, opto electronic ICs, Buffer.

TOTAL : 45 PERIODS

OUTCOMES:

1. Explain the different fabrication methods of integrated circuits.
2. Explain the characteristics, frequency response and applications of OP-AMP based circuits
3. Explain the different special ICs and Application ICs and its characteristics.

TEXT BOOKS:

1.	Ramakant A. Gayakward, "Op-amps and Linear Integrated Circuits", 4th Education, 2003.
2.	Roy Choudhary. D, SheilB.Jani, "Linear Integrated Circuits", 2nd Edition, New Age, 2003.
3.	Fiore, "Op-amps&Linear IntegratedCircuitsConcepts&Applications",Cengage, 2010.

REFERENCES:

1.	*Jacob Millman, Christos C.Halkias, "Integrated Electronics - Analog and Digital circuits system", Tata McGraw Hill, 2003.*
2.	*Robert F.Coughlin, Fredrick F.Driscoll, "Op-amp and Linear ICs", 4th Edition,Pearson*
3.	*David A.Bell, "Op-amp & Linear ICs", 2nd Edition, Prentice Hall of India, 1997.*
4.	*Floyd, Buchla,"FundamentalsofAnalogCircuits",Pearson,2013.*

17PTEPC304	**DIGITALLOGICCIRCUITS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

•	To study various number systems , simplify the logical expressions using Boolean functions
•	To study implementation of combinational circuits
•	To design various synchronous and asynchronous circuits.
•	To introduce asynchronous sequential circuits and PLCs
•	To introduce digital simulation for development of application oriented logic circuits.

UNIT I	**NUMBER SYSTEMS AND DIGITAL LOGIC FAMILIES**	**9**

Review of number systems, binary codes, error detection and correction codes (Parity and Hamming code) –Digital Logic Families, comparison of RTL, DTL, TTL,ECL and MOS families-operation, characteristics of digital logic family.

UNIT II	**COMBINATIONAL CIRCUITS**	**9**

Combinational logic-representation of logic functions-SOP and POS forms, K-map representations- minimization using Kmaps-simplification and implementation of combinational logic–multiplexers, demultiplexers, encoders and decoders- code converters, adders and subtractors.

UNIT III	**SYNCHRONOUS SEQUENTIAL CIRCUITS**	**9**

Sequential logic - SR, JK, D and T flipflops –level triggering and edge triggering -counters- a synchronous and synchronous type - Modulo counters- Shift registers – design of synchronous sequential circuits –Moore and Melay models-Counters, state diagram; state reduction; state assignment

UNIT IV	**ASYNCHRONOUS SEQUENTIAL CIRCUITS AND PROGRAMMABLE LOGIC DEVICES**	**9**

Asynchronous sequential logic circuits - Transition table, flow table-race conditions, hazards & errorsin digital circuits; analysis of asynchronous sequential logic circuits-introduction to Programmable Logic Devices:PROM–PLA–PAL.		
UNIT V	**VHDL**	**9**
RTL Design–combinational logic –Sequential circuit–Operators –Introduction to Packages – Subprograms–Test bench.(Simulation/Tutorial Examples: adders, counters, flip-flops, FSM, Multiplexers /Demultiplexers).		
		TOTAL : 45 PERIODS

OUTCOMES:	
1.	Explain the different number systems and coding schemes and arithmetic operations on binary numbers.
2.	Explain the IC fabrication technique, operation of logic gates and their family.
3.	Explain the basic theorems and properties of Boolean algebra, Utilize K- Map for gate level minimization of the given Boolean function and Construct combinational logic circuits for the given requirement and determine their performance.
4.	Construct synchronous and asynchronous sequential logic circuits for the given requirement and determine their performance.
5.	Explain the programmable logic devices such as PROM, PLA, and PAL, and VHDL Programming.

TEXT BOOKS:

1.	Raj Kamal,'Digital systems-Principles and Design',PearsonEducation2nd edition, 2007
2.	M.Morris Mano,'Digital Design with an introduction to the VHDL',Pearson Education, 2013.
3.	Floyd and Jain, 'Digital Fundamentals',8thedition,PearsonEducation,2003.
4.	Anil K.Maini, "Digital Electronics: Principles, Devices and Applications", Wiley Publications, 2007.

REFERENCES:

1.	*Mandal "Digital Electronics Principles & Application, McGrawHill Edu,2013*
2.	*William Keitz, "Digital Electronics-A Practical Approach with VHDL", Pearson, 2013.*
3.	*Comer "Digital Logic & State Machine Design", Oxford, 2012.*
4.	*Anand Kumar, "Fundamentals of Digital Circuits", PHI, 2013.*

17PTEPC305	CONTROL AND INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES :

•	To provide knowledge on design and analysis of frequency response and stability of various order system using Simulation tool
•	To provide knowledge on design and analysis of various compensators
•	To study the Characteristics of Synchro-Transmitter- Receiver and Position Control Systems
•	To conduct experiment on DC and AC Bridges to find unknown values of circuits elements
•	To provide knowledge characteristics of signal conditioning devices.

LISTOFEXPERIMENTS:

CONTROLSYSTEMS:

1. Simulation of First and second order Systems
2. P, PI and PID controllers
3. Stability Analysis
4. Modelling of Systems–Machines, Sensors and Transducers
5. Design of Lag, Lead and Lag-Lead Compensators
6. Position Control Systems
7. Synchro -Transmitter- Receiver and Characteristics

INSTRUMENTATION:

8. Bridge Networks–AC and DC Bridges
9. Dynamics of Sensors/Transducers
   a. Temperature b. Pressure, c. Displacement, d. Optical, e. Strain f. Flow
10. Signal Conditioning
    a. Instrumentation Amplifier

b. Analog–Digital and Digital–Analog converters (ADC and DACs), Active Filters

TOTAL : 45 PERIODS

OUTCOMES:

1.	Analyse the time response, frequency response and stability of various order system using Simulation tool
2.	Design the series compensators,
3.	Analyse the characteristics of various control and instrument elements.
4.	Analyse the characteristics of signal conditioning devices.

Semester IV

17PTEPC401	MICROPROCESSORS, MICRO CONTROLLERS AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES :

- To provide training on programming of microprocessors and microcontrollers to perform basic binary and mathematical operations like Addition, Subtraction, Multiplication, Division
- To provide training on programming of microprocessors and microcontrollers using fundamental features and operations
- To impart knowledge to Develop Assembly Language Program that will provide solutions to real world control problems like Speed control, traffic light control.
- To impart knowledge to Choose appropriate peripheral interfacing devices with 8085& 8051 for specific applications.
- T o study the Measurement of frequency of the given waveform using microcontroller

UNIT I	INTRODUCTION TO MICROPROCESSORS	9

Hardware Architecture pin outs - Signals – Memory interfacing – I/O ports and data transfer concepts– Timing Diagram – Interrupt structure. Introduction to 8086 processor (Architecture and modes of operation only).

UNIT II	PROGRAMMING OF 8085 PROCESSOR	9

Instruction format and addressing modes – Assembly language format – Data transfer, data manipulation& control instructions – Programming: Loop structure with counting & Indexing – Lookup table - Subroutine instructions - stack.

UNIT III	8051 MICRO CONTROLLER	9

Functional block diagram - Instruction format and addressing modes – Timing Diagram Interrupt structure – Timer –I/O ports – Serial communication.

UNIT IV	PERIPHERAL INTERFACING-8051	9

Study of Architecture and programming of ICs: 8255 PPI, 8259 PIC, 8251 USART, 8279 Key board display controller and 8253 Timer/ Counter-A/D and D/A converter interfacing, interfacing with LCD, digital IOs, keypad and memory.

UNIT V	MICRO CONTROLLER PROGRAMMING AND APPLICATIONS	9

Data Transfer, Manipulation, Control & I/O instructions – Simple programming exercises key board and display interface – Design of PID controller - Closed loop control of servo motor - Stepper motor control - Washing Machine Control.

TOTAL : 45 PERIODS

OUTCOMES:

1.	Explain the architecture of Microprocessors and its blocks.
2.	Write the program for various functions using 8085 processor.
3.	Explain the architecture, Program structure, and peripheral interfacing of 8051 Microcontrollers.
4.	Apply the 8051 microcontroller into various applications.
TEXT BOOKS:	
1.	Senthilkumar N. and Saravanan M. "Microprocessor and Microcontrollers", Oxford University Press, 2011
2.	Krishna Kant "Microprocessor and Microcontrollers" Eastern Company Edition, Prentice – Hall of India, New Delhi, 2007
3.	Ramesh Gaonkar, 'Microprocessor Architecture Programming and Application', CBS Publishers 2011.
REFERENCES:	
1.	*Ankaj Gupta "Microcontroller and Embedded System"S.K.Kataria and Sons Publishers 2013*
2.	*Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely"The 8051 Micro Controller and Embedded Systems" (Using Assembly Language and C), PHI Pearson Education, 2011*
3.	*The 8088 & 8086 Microprocessors , Walter A Tribal &Avtar Singh, Pearson, 200*
4.	*Singh B.P., Renu Singh "Advanced Microprocessors and Microcontrollers", New Age International Private Limited, 2009.*

17PTEPC402	POWER ELECTRONICS	L	T	P	C
		3	0	0	3

OBJECTIVES :	
•	To get an overview of different types of power semiconductor devices and their switching characteristics.
•	To understand the operation, characteristics and performance parameters of controlled rectifiers.
•	To study the operation, switching techniques and basics topologies of DC-DC switching regulators.
•	To study the operation of AC voltage controller and various configurations.
•	To learn the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.

UNIT I	POWER SEMI-CONDUCTOR DEVICES	9

Basic structure-VI and switching characteristics of SCR, TRIAC, DIAC, Power BJT, Power MOSFET and IGBT –Driver and Snubber circuit-Commutation circuit for SCR.

UNIT II	PHASE-CONTROLLED CONVERTERS	9

2-pulse, 3-pulse and 6-pulse converters – Effect of source inductance – Performance parameters –Power factor control – Dual converters.

UNIT III	DC TO DC CONVERTER	9

Step-down and step-up chopper – Time ratio control and current limit control – Switching mode regulators -Buck, Boost, Buck-Boost and Cuk regulator - Concept of resonant switching.

UNIT IV	AC TO AC CONVERTERS	9

Introduction to phase control and Integral cycle control -Single phase and three AC voltage controllers -– Multistage sequence control - Single and three phase cyclo converters.

UNIT V	INVERTERS	9

Single phase and three phase (both 120º mode and 180º mode) inverters – PWM techniques: Single PWM- Multiple PWM - Sinusoidal PWM, modified sinusoidal PWM — Voltage and harmonic control – Series resonant inverter – Current source inverter- Uninterrupted power supply topologies.

TOTAL : 45 PERIODS

OUTCOMES:

1.Explain the characteristics of various power semiconductor devices

2.Design and analyse the performance of Phase controlled, AC-AC, and DC-DC converters.

3.Design and analyse the performance of various Inverters.

TEXT BOOKS:

1.	Rashid M.H., “Power Electronics: Circuits, Devices and Applications”, Pearson Education, PHI, New Delhi, 3rd Edition, 2004.
2.	Bimbra P.S., “Power Electronics”, Khanna Publishers, 3rd Edition, 2003.
3.	Singh M. D. and Khanchandani K. B., “Power Electronics” Tata McGraw-Hill

	Publishing Company Limited, New Delhi, 3rd Edition, 2008.
REFERENCES:	
1.	*Ashfaq Ahmed, "Power Electronics for Technology", Pearson Education, Indian reprint, 2003.*
2.	*Philip T. Krein, "Elements of Power Electronics", Oxford University Press, 2004.*
3.	*Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and sons, 3rd Edition, 2003.*
4.	*Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, 2003.*

17PTEPC403	SYNCHRONOUS AND ASYNCHRONOUS MACHINES	L	T	P	C
		3	0	0	3

OBJECTIVES :

- To impart knowledge on Construction, principle of operation and performance of three phase induction motor
- To impart knowledge on Starting and speed control of three-phase induction motors.
- To impart knowledge on Construction, principle of operation and performance of single phase induction motors and special machines.
- To impart knowledge on Construction and performance of salient and non – salient type synchronous generators.
- To impart knowledge on Principle of operation and performance of synchronous motor.

UNIT I	THREE PHASE INDUCTION MOTOR	9

Constructional details–Types of rotors–-Principle of operation– Slip–cogging and crawling-Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque – Losses and efficiency–Loadtest-Noloadandblockedrotortests-Circlediagram–Separationof losses–Doublecageinductionmotors–Inductiongenerators–Synchronousinductionmotor.

UNIT II	STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR	9

Need for starting–Types of starters–DOL, Rotor resistance, Autotransformer and Star-delta starters–Speed control–Voltage control, Frequency control and pole changing –Cascaded connection-V/f control–Slip power recovery scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.

UNIT III	SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES	9

Constructional details of single phase induction motor–Double field revolving theory and operation – Equivalent circuit–No load and blocked rotor test–Performance analysis–Starting methods of single-phase induction motors–Capacitor-start capacitor run Induction motor-Shaded pole induction motor - Linear induction motor –Repulsion motor- Hysteresis motor-AC series motor- Servomotors- Stepper motors- introduction to magnetic levitation systems.

UNIT IV	SYNCHRONOUS GENERATOR	9

Constructional details–Types of rotors–winding factors - emf equation–Synchronous reactance – Armature reaction–Phasor diagrams of non-salient pole synchronous generator connected to infinite bus--Synchronizing and parallel operation – Synchronizing torque - Change of excitation and mechanical input- Voltage regulation–EMF, MMF, ZPF and A.S.A methods–steady state power- angle characteristics–Two reaction theory–slip test-short circuit transients- Capability Curves.

UNIT V	SYNCHRONOUS MOTOR	9

Principle of operation–Torque equation–Operation on infinite bus bars- V and Inverted V curves– Power input and power developed equations – Starting methods –Current loci for constant power input, constant excitation and constant power developed-Hunting–natural frequency of oscillations– damper windings- synchronous condenser.	
	TOTAL : 45 PERIODS
OUTCOMES:	
1.	Explain the construction, operation and characteristics of Induction Motors and Special electrical machines.
2.	Describe various starters and speed control methods of induction motors.
3.	Explain the construction, operation and characteristics of Synchronous machines.
4.	Determine the losses and efficiency in ac machines.
TEXT BOOKS:	
1.	A.E.Fitzgerald, Charles Kingsley, Stephen.D.Umans, 'Electric Machinery', Tata McGraw Hill publishing Company Ltd, 2003.
2.	D.P.Kothari and I.J.Nagrath, 'Electric Machines', Tata McGraw Hill Publishing Company Ltd, 2002.
3.	P.S.Bhimbhra, 'Electrical Machinery', KhannaPublishers, 2003.
REFERNCES:	
1.	*M.N.Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning PVTLTD., NewDelhi,2009.*
2.	*Charless A.Gross, "Electric /Machines,"CRCPress,2010.*
3.	*K.Murugesh Kumar, 'Electric Machines', Vikas Publishing HousePvt.Ltd,2002.*
4.	*Alexander S.Langsdorf, Theory of Alternating – Current Machinery, Tata McGraw Hill Publications, 2001.*

17PTEPC404	TRANSMISSION AND DISTRIBUTION	L	T	P	C
		3	0	0	3

OBJECTIVES :

- To impart knowledge on Construction, principle of operation and performance of three phase induction motor
- To impart knowledge on Starting and speed control of three-phase induction motors.
- To impart knowledge on Construction, principle of operation and performance of single phase induction motors and special machines.
- To impart knowledge on Construction and performance of salient and non – salient type synchronous generators.
- To impart knowledge on Principle of operation and performance of synchronous motor.

UNIT I	POWER SYSTEM TOPOLOGY	9

Structure of electric power system – Generation, Transmission and distribution voltages – HVDC system – structure – Types - Comparison of AC and DC system - EHV AC transmission- need and environmental aspects – FACTS- TCSC – SVC – STATCOM – UPFC (qualitative treatment only) –Mechanical design of transmission line between towers – sag and tension- calculations using approximate equations taking into account the effect of ice and wind.

UNIT II	TRANSMISSION LINE PARAMETERS	9

Transmission line Resistance - Inductance and Capacitance calculations for - single and three phase transmission lines with single and double circuits lines - Symmetrical and unsymmetrical spacing -Transposition - Application of self and mutual GMD -Stranded and bundled conductors - Skin and proximity effects.

UNIT III	MODELLING AND PERFORMANCE OF TRANSMISSION LINES	9

Classification of lines – Short, medium and long transmission lines – Equivalent circuits Transmission efficiency and voltage regulation – Generalized constants of the transmission line- Surge impedance – Surge impedance loading- Real and reactive power flow in the line- Power angle diagram - Power circle diagrams – Ferranti effect -corona formation and loss.

UNIT IV	INSULATORS AND CABLES	9

Insulators – Types – Voltage distribution in string insulator and grading – Improvement of string efficiency – Underground cables – Constructional features of LT and HT cables – Capacitance single core and three core cables – Dielectric stress and grading – Thermal characteristics.

UNIT V	SUBSTATION AND DISTRIBUTION SYSTEM	9

Types of substations- substation equipment – Bus-bar arrangements – Substation bus schemes –Single bus scheme – Double bus with double breaker – Double bus with single breaker – Main and transfer bus – Ring bus – Breaker-and-a-half with two main buses – Double bus-bar with bypass isolators. Neutral grounding- System and equipment grounding- grounded and

ungrounded transmission system- Solid, Resistance, reactive, Peterson coil grounding systems –Distribution systems- types -Radial and ring main (qualitative treatment only).	
	TOTAL : 45 PERIODS
OUTCOMES:	
1.	Explain the basic structure of electric power systems, FACTS devices, and Calculate the sag of transmission lines.
2.	Calculate the line parameters for various type of lines.
3.	Explain the characteristics and performance of short, medium and long transmission lines.
4.	Explain the construction and performance of insulators and cables
5.	Explain the basic structure of substations and distribution systems.
TEXT BOOKS:	
1.	Wadhwa C.L., "Electric Power Systems", New Age International (P) Ltd., 2000.
2.	Gupta B.R., "Power System Analysis and Design", S. Chand Company & Ltd, New Delhi, 2003.
3.	D.P.Kothari, I.J.Nagarath, 'Power System Engineering', Tata McGraw - Hill Publishing Company limited, New Delhi,Second Edition,2008.
REFERENCES:	
1.	*Singh S.N., "Electric Power Generation, Transmission and Distribution", Prentice Hall of India, New Delhi, 2002.*
2.	*Mehta V. K. and Rohit Mehta, "Principles of Power System", S.Chand Company & Ltd, New Delhi, 2006.*
3.	*J.Brian, Hardy and ColinR.Bayliss, 'Transmission and Distribution in Electrical Engineering', Newnes;Fourth Edition,2012.*
4.	*Luces M.Fualkenberry, Walter Coffer, 'Electrical Power Distribution and Transmission', Pearson Education,2007.*
5.	*Wiiliam D. Stevenson Jr, "Elements of Power system Analysis", TataMcGraw-Hill Publishing Company limited, NewDelhi.*

17PTEPC405	ELECTRICAL MACHINES LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES :

•	To expose the students to the operation of various D.C. generators and give them experimental skill.
•	To expose the students to the operation of various D.C. motors and give them experimental skill.
•	To expose the students to the operation transformers and give them experimental skill to find the efficiency , losses and to draw the equivalent circuit
•	To study the various methods of regulation calculation of alternator.
•	To estimate the various losses takes place in Induction Motor and to study the load test methods to arrive at their performance.

LISTOFEXPERIMENTS:

1. Study of DC and AC Starters.
2. Open circuit and load characteristics of D.C shunt generator.
3. Load test on D.C shunt and Series Motor.
4. Load test on Alternator.
5. Swinburne's test and speed control of D.C shunt motor
6. Hopkinson's test on D.C. Motor generation set.
7. Load test on single phase and three phase transformer.
8. Open circuit and short circuit tests on single phase transformer.
9. Load test on single phase induction motor.
10. Noloadandblockedrotortestsonthreephaseinductionmotor.
11. Load test on Three phase induction motor.
12. V-Curve and inverted V-Curve of synchronous Motor.

LISTOFEQUIPMENTSFORABATCHOF30STUDENTS:

1. DCShuntMotor withLoadingArrangement–3Nos
2. SinglePhaseTransformer –4Nos
3. DC Series Motor with Loading Arrangement–1 No
4. Three Phase Induction Motor with Loading Arrangement–2 Nos
5. Single Phase Induction Motor with Loading Arrangement–1 No.
6. DC Shunt Motor Coupled With DC Shunt Generator–1 No
7. Tachometer -Digital/Analog–8Nos
8. Single Phase Auto Transformer – 2 Nos
9. Three Phase Auto Transformer–1 No
10. Single Phase Resistive Loading Bank –2 Nos
11. Three Phase ResistiveLoadingBank.–2 Nos
12. SPST switch–2Nos
13. Single Phase Transformer -1No
14. Three Phase Transformer -1 No

15.Three Phase Alternator -1 No	
	TOTAL : 45 PERIODS
OUTCOMES:	
1.	Able to draw the characteristics of DC Generators and Motors and determine the losses and efficiency.
2.	Able to draw the equivalent circuit and characteristics of transformers and determine the losses and efficiency.
3.	Able to draw the characteristics of Induction Motors and determine the losses and efficiency.
4.	Able to draw the characteristics of Synchronous Motors and Alternators and determine the Voltage regulation and efficiency.

Semester V

17PTEPC501	POWER SYSTEM ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES :

- To model the power system under steady state operating condition.
- To study numerical methods and matrices
- To apply numerical methods to solve the power flow problem.
- To model and analyze the system under faulted conditions.
- To model and analyze the transient behaviour of power system when it is subjected to a fault.

UNIT I	POWER SYSTEM MODELING	9

Basic components of a power system– Per phase and per unit analysis– Modeling of power system components in per unit analysis - Symmetrical Components and sequence networks – Modeling of components in positive, negative and zero sequences. – Impedance and Reactance Diagram.

UNIT II	NETWORK MATRICES	9

Primitive Networks – Construction of Ybus using inspection and singular transformation methods. – Direct Building algorithm of Zbus matrix - Sparse Matrix techniques for large scale power systems: Factorization by Bifactorization and Gauss elimination methods; Repeat solution using Left and Right factors and L and U matrices.

UNIT III	POWER FLOW ANALYSIS	9

Classification of Buses – Power flow problem formulation in rectangular and polar forms– Solution of Power flow problem: Gauss Seidel method, Newton Raphson method, and Fast decoupled power flow method. Comparison of methods – Statement of Optimal Power Flow

UNIT IV	FAULT ANALYSIS	9

Need for fault analysis in power systems – Symmetrical Fault analysis using Zbus – Computation of fault current, short circuit capacity and post fault voltages – Unsymmetrical faults in transmission lines– Sequence network interconnection for various faults – Unsymmetrical fault analysis using symmetrical components.

UNIT V	POWER SYSTEM STABILITY	9

Need for stability – Classification of power system stability-angle and voltage stability– Small signal stability analysis of single machine infinite bus system –Solution of swing equation by modified Euler method and Runge-Kutta fourth order method – Implicit integration methods – Multi machine Infinite bus system – Introduction to Transient stability.

TOTAL : 45 PERIODS

OUTCOMES: After successful completion of the course students able to

1.	Calculate pu quantity for the given components.
2.	Compute Y-Bus and Z-Bus.
3.	Analyze the various faults in power transmission line.

4.	Analyze the stability of single machine and Multi machine infinite bus system.
TEXT BOOKS :	
1	Nagrath I.J.and Kothari D.P.,'Modern Power System Analysis',TataMcGraw-Hill,Fourth Edition, 2011.
2	C.L.Wadhwa, 'Electrical Power Systems 'New Academic Science Limited, 2017.
3	Ashfaq Husain,'Electrical Power System' 5th edition, CBS Publishers, 2017.
4	P.Venkatesh, B.V.Manikandan, S.CharlesRaja, A.Srinivasan,'Electrical Power Systems Analysis, Security and Deregulation',PHI Learning Private Limited, New Delhi,2012.
REFERNCES:	
1	*Hadi Saadat, 'Power System Analysis',Tata McGraw Hill Education Pvt.Ltd.,New Delhi,21st reprint, 2010.*
2	*Kundur P., 'Power System Stability and Control,Tata McGraw Hill Education Pvt.Ltd.,NewDelhi 10th reprint, 2010*
3	*J.Duncan Glover, Mulukutla S.Sarma,Thomas J.Overbye,'Power System Analysis &Design', Cengage Learning,Fifth Edition,2012.*
4	*John J.Grainger and W.D.Stevenson Jr., 'Power System Analysis', Tata McGraw-Hill,Sixth reprint, 2010.*

17PTEPC502	HIGH VOLTAGE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the various types of over voltages in power system and protection methods.
- Generation of over voltages in laboratories.
- Measurement of over voltages.
- Nature of Breakdown mechanism in solid, liquid and gaseous dielectrics.
- Testing of power apparatus and insulation coordination.

UNIT I	OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS	9

Causes of over voltages and its effects on power system–Lightning, switching surges and temporary over voltages, Corona and its effects–Reflection and Refraction of Travelling waves- Protection against over voltages.

UNIT II	DIELECTRIC BREAKDOWN	9

Gaseous breakdown in uniform and non-uniform fields–Corona discharges–Vacuum breakdown– Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics.

UNIT III	GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS	9

Generation of High DC: Voltage doubler, Voltage multiplier circuits and Van de Graff generator, Generation of High AC: Cascade Transformer and Resonant transformer, Circuits for impulse voltages and currents generation- Tripping and control of impulse generator.

UNIT IV	MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS	9

High Resistance with series ammeter–Dividers, Resistance, Capacitance and Mixed dividers- Peak Voltmeter, Generating Voltmeters-Capacitance Voltage Transformers, Electrostatic Voltmeters– Sphere Gaps- High current shunts- Digital techniques in high voltage measurement.

UNIT V	HIGH VOLTAGE TESTING & INSULATION COORDINATION	9

High voltage testing of electrical power apparatus as per International and Indian standards– Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers- Insulation Coordination.

	TOTAL : 45 PERIODS

OUTCOMES:	After successful completion of the course students able to
1.	Explain the causes and effects of over voltages and transients
2.	Know the electrical breakdown on various medium
3.	Design the generation circuit of overvoltage, impulse voltage and Current.
4.	Measure the overvoltage and current using various components.
5.	Test the electrical apparatus against over voltages and impulse current.
TEXT BOOKS:	
1.	M.S.Naidu andV.Kamaraju,'High Voltage Engineering',Tata McGraw Hill,Fifth Edition, 2013.
2.	E.Kuffel and W.S.Zaengl, J.Kuffel,'High voltage Engineering fundamentals ',Newnes Second Edition Elsevier ,New Delhi,2005.
3.	Subir Ray,'An Introduction to High Voltage Engineering'PHI Learning Private Limited, New Delhi, Second Edition, 2013.
REFERENCES:	
1.	*L.L.Alston,'High Voltage Technology',Oxford University Press, First Indian Edition, 2011.*
2.	*C.L.Wadhwa,'High voltage Engineering',NewAge International Publishers,Third Edition,2010*

17PTEPC503	ELECTRICAL MACHINE DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:	
1.	To study mmf calculation and thermal rating of various types of electrical machines
2.	To design armature and field systems for D.C. machines
3.	To design core, yoke, windings and cooling systems of transformers.
4.	To design stator and rotor of induction machines.
5.	To design stator and rotor of synchronous machines and study their thermal behaviour.

UNIT I	INTRODUCTION	9

Major considerations in Electrical Machine Design - Electrical Engineering Materials - Space factor – Choice of Specific Electrical and Magnetic loadings – Thermal consideration - Heat Dissipation - Temperature gradient in cores slots and windings - Rating of machines – Standard specifications. Introduction to Computer aided Design in Electrical Machines (Simple Treatment).

UNIT II	DC MACHINES	9

Output Equations – Main Dimensions - Magnetic circuit calculations - Carter's Coefficient - Netlength of Iron –Real & Apparent flux densities – Selection of number of poles – Design of Armature – Design of commutator and brushes – Design of field winding.

UNIT III	TRANSFORMERS	9

Output Equations – Main Dimensions - KVA output for single and three phase transformers – Window space factor – Design of core and windings - Overall dimensions – No load current– Temperature rise in Transformers – Design of Tank with cooling tubes - Methods of cooling of Transformers.

UNIT IV	INDUCTION MOTORS	9

Output equation of Induction motor – Main dimensions – Length of air gap- Rules for selecting rotor slots of squirrel cage machines – Design of rotor bars & slots – Design of end rings – Design of wound rotor -– Magnetic leakage calculations – Leakage reactance of polyphase machines - Magnetizing current - Short circuit current .

UNIT V	SYNCHRONOUS MACHINES	9

Output equations – choice of loadings – Design of salient pole machines – Short circuit ratio – shape of pole face – Armature design – Armature parameters – Estimation of air gap length – Design of rotor –Design of damper winding – Design of field winding – Design of turbo alternators – Rotor design.	
	TOTAL : 45 PERIODS
OUTCOMES:	After successful completion of the course students able to
1.	Formulate Specific Electrical and Magnetic loadings for various electrical DC and AC machines.
2.	Devise main dimensions (D, L) of armature and field systems for D.C. machines.
3.	Design overall Dimensions of single and three phase transformers core, windings and cooling systems for transformers
4.	Design main dimensions of squirrel cage and Slip ring induction machines.
5.	Design main dimensions of Synchronous machines.
TEXT BOOKS:	
1.	Sawhney A.K., *"*A Course in Electrical Machine Design*",* Dhanpat Rai & Sons, New Delhi, 2006.
2.	Sen S.K., "Principles of Electrical Machine Designs with Computer Programmes", Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2009.
3.	Shanmugasundaram A., Gangadharan G. and Palani R., "Electrical Machine Design Data Book", New Age International Pvt. Ltd., Reprint 2007.
REFERENCES:	
1.	*Say.M.G, "The Performance and Design of Alternating current Machines", Isaac Pitman & sons Limited, 1995.*

17PTEPC505	MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES :	
1.	To provide training on programming of microprocessors and microcontrollers to perform basic binary and mathematical operations like Addition, Subtraction, Multiplication, Division
2.	To provide training on programming of microprocessors and microcontrollers using fundamental features and operations
3.	To impart knowledge to Develop Assembly Language Program that will provide solutions to real world control problems like Speed control, traffic light control.
4.	To impart knowledge to Choose appropriate peripheral interfacing devices with 8085& 8051 for specific applications.
5.	To study the Measurement of frequency of the given waveform using microcontroller

1. Programming for 8/16 bit Arithmetic operations using 8085: Addition / Subtraction / Multiplication / Division.

2. Programming with control instructions using 8085: Increment / Decrement, Ascending /Descending order, Maximum / Minimum of numbers, Rotate instructions, Hex / ASCII / BCD code conversions.

3. Interface Experiments using 8085: A/D Interfacing, D/A Interfacing, Traffic light controller, Simple experiments using 8251, 8253,8255, 8279

4. Interfacing of DC Motor Speed control using 8085

5. Interfacing of Stepper Motor control using 8085

6. Programming for 8/16 bit Arithmetic operations using 8051: Addition / Subtraction / Multiplication / Division.

7. Demonstration of basic instructions with 8051 Microcontroller execution, including: Conditional jumps, looping, calling subroutines.

8. Interface Experiments using 8051: A/D Interfacing, D/A Interfacing.

9. Interfacing of DC Motor Speed control using 8051.

10. Interfacing of Stepper Motor control using 8051.

11. Measurement of frequency of the given waveform using microcontroller.

	TOTAL: 45 PERIODS
OUTCOMES:	After successful completion of the course students able to
1	Develop basic binary and mathematical operations like Addition, Subtraction, Multiplication, Division using microprocessor and microcontroller.
2	Describe the fundamental features and operations of contemporary microcontroller and microprocessor.
3	Develop Assembly Language Program that will provide solutions to real world control problems like Speed control, traffic light control.
4	Choose appropriate peripheral interfacing devices with 8085& 8051 for specific applications.

Semester-VI

17PTEPC601	POWER SYSTEM OPERATION AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES :

1.	To have an overview of power system operation and control.
2.	To study the economic operation of power system
3.	To model power-frequency dynamics and to design power-frequency controller.
4.	To model reactive power-voltage interaction and the control actions to be implemented for maintaining the voltage profile against varying system load.
5.	To teach about SCADA and its application for real time operation and control of power systems

UNIT I	CHARACTERISTICS OF LOADS	9

Basics of Power system control and operation – Real and Reactive power of Loads - System load variation – Load characteristics – Load curves and Load Duration curve – load factor and diversity factor - Reserve requirements: Installed reserves, spinning reserves, cold reserves, hot reserves –Overview of system operation: Load forecasting, techniques of forecasting, Importance of load forecasting.

UNIT II	POWER SYSTEM OPERATION	9

Statement of Unit Commitment problem - Constraints - Solution methods: Priority-list methods, forward dynamic programming approach – Formulation of economic dispatch problem with and without losses - Solution by direct method and λ-iteration method. - Base point and participation factors – Hydrothermal scheduling problem – Short term and long term model and algorithm – Dynamic Programming solution methods for hydrothermal scheduling (Qualitative treatment only).

UNIT III	ACTIVE POWER FREQUENCY CONTROL	9

Basics of speed governing mechanism and modeling- speed-load characteristics–Parallel operation of Alternators- LFC control of a single-area system–Static and Dynamic characteristics – PI controller in LFC– LFC in Two area system – Static analysis with uncontrolled case- tie line with frequency bias control- State model– LFC with Economic dispatch controller. Software simulation of LFC (Single Area and Two area system).

UNIT IV	REACTIVE POWER VOLTAGE CONTROL	9

Generation, Absorption and control of reactive power– Modeling of excitation systems – Static and dynamic characteristics-Stability compensation- Secondary voltage control – Tap changing transformers for voltage control – FACTS applications to reactive power control: STATCOM,

SVC, TCS and TSC.		
UNIT V	**SMART POWER CONTROL**	**9**
Need for smart control of power systems-concept of energy control centre- functions-system monitoring -dataacquisition and control-system hardware configuration–SCADA and EMS functions-network topology-state estimation–WLSE-Contingency Analysis-state transition diagram showing various state transitions and control strategies. Recent trends in power system control.		
	TOTAL : 45 PERIODS	

OUTCOMES:	After successful completion of the course students able to
1.	Analyse the loads and apply forecasting methods for power system restructuring.
2.	Operate the generating units in an efficient way to reduce fuel cost.
3.	Design load frequency controller to regulate the frequency and speed.
4.	Design the excitation systems with appropriate voltage controllers to regulate voltage and compensate reactive power.
5.	Apply smart techniques in power system security.

TEXT BOOKS:

1.	Olle.I.Elgerd,'Electric Energy Systems theory- An introduction',TataMcGrawHill EducationPvt.Ltd.,NewDelhi,34threprint, 2010.
2.	Allen.J.Wood and Bruce F.Wollenberg,'Power Generation,Operation and Control',JohnWiley &Sons,Inc.,2003.
3.	Abhijit Chakrabarti, Sunita Halder,'Power System Analysis Operation and Control',PHI learning Pvt.Ltd.,NewDelhi,Third Edition,2010.
4.	Badri Ram, D. N. Vishwakarma ,'Power System Protection and Switchgear' Tata McGraw-Hill Education, 2001.

REFERENCES:

1.	*Nagrath I.J.and Kothari D.P.,'Modern Power System Analysis',TataMcGraw-Hill,Fourth Edition ,2011.*
2.	*Kundur P.,'Power System Stability and Control,Tata McGraw'Hill Education Pvt.Ltd.,New Delhi ,10threprint, 2010.*
3.	*Hadi Saadat,'Power System Analysis',Tata McGraw Hill Education Pvt.Ltd.,New Delhi,21st reprint, 2010.*
4.	*N.V.Ramana,"Power System Operation and Control," Pearson,2011.*

5.	*C.A.Gross,"PowerSystem Analysis,"Wiley India,2011.*
6.	*Sunil S Rao,'Switchgear Protection And Power Systems (Theory, Practice & Solved Problems), Khanna Publishers,2008*
7.	*M. L. Soni, P. V. Gupta, U. S. Bhatnagar ,'A Course in Electrical Power' Dhanpat Rai, 1987.*

17PTEPC602	PROTECTION AND SWITCHGEAR	L	T	P	C
		3	0	0	3

OBJECTIVES :

- To educate the causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
- To introduce the characteristics and functions of relays and protection schemes.
- To impart knowledge on apparatus protection
- To introduce static and numerical relays
- To impart knowledge on functioning of circuit breakers

UNIT I	PROTECTION SCHEMES	9

Principles and need for protective schemes–nature and causes of faults–types of faults– fault current calculation using symmetrical components–Methods of Neutral grounding–Zones of protection and essential qualities of protection–Protection schemes

UNIT II	ELECTROMAGNETIC RELAYS	9

Operating principles of relays - the Universal relay – Torque equation – R-X diagram – Electromagnetic Relays–Overcurrent, Directional, Distance, Differential, Negative sequence and Under frequency relays.

UNIT III	APPARATUS PROTECTION	9

Current transformers and Potential transformers and their applications in protection schemes - Protection of transformer, generator, motor, busbars and transmission line.

UNIT IV	STATIC RELAYS AND NUMERICAL PROTECTION	9

Static relays–Phase, Amplitude Comparators–Synthesis of various relays using Static comparators – Block diagram of Numerical relays–Over current protection, transformer differential protection distant protection of transmission lines.

UNIT V	CIRCUIT BREAKERS	9

Physics of arcing phenomenon and arc interruption- DC and AC circuit breaking–

re-striking voltage and recovery voltage-rate of rise of recovery voltage-resistance switching-current chopping- interruption of capacitive current-Types of circuit breakers–air blast, air break, oil,SF6 and vacuum circuit breakers–comparison of different circuit breakers– Rating and selection of Circuit breakers

	TOTAL : 45 PERIODS

OUTCOMES:	After successful completion of the course students able to
1.	Analyze the faults and apply protection schemes for lines.
2.	Apply the electromagnetic relays for various protection systems.
3.	Design proper protection scheme for generators, transformers, and other power system equipments.
4.	Apply the static relays into numerical protection schemes.
5.	Analyze the various circuit breakers and apply them into proper protection system.

TEXT BOOKS:	
1.	Sunil S.Rao, 'Switchgear and Protection',Khanna Publishers,NewDelhi,2008.
2.	B.Rabindranath and N.Chander, 'Power System Protection and Switchgear', New Age International
3.	M.L.Soni, P.V.Gupta, U.S.Bhatnagar, A.Chakrabarti, 'A Text Book on Power System Engineering', Dhanpat Rai & Co., 1998.

REFERENCES:	
1.	*Badri Ram ,B.H.Vishwakarma,'PowerSystem Protection and Switchgear', New Age International*
2.	*Y.G.Paithankar and S.R.Bhide, 'Fundamentals of power system protection', Second Edition, Prentice Hall of India Pvt.Ltd., New Delhi, 2010.*
3.	*C.L.Wadhwa,'Electrical Power Systems', 6th Edition,New Age International (P) Ltd.,*

17PTEPC603	PROFESSIONAL ETHICS	L	T	P	C
		3	0	0	3

OBJECTIVES :

- To enable the students to create an awareness on Engineering Ethics
- To study the engineering as social experimentation
- To impart knowledge on engineer's responsibility for safety
- To impart knowledge on engineer's responsibility and rights
- To study the global issues on business

UNIT I ENGINEERING ETHICS 9

Senses of 'Engineering Ethics'– Variety of moral issues–Types of inquiry–Moral dilemmas–Moral Autonomy–Kohlberg's theory–Gilligan's theory–Consensus and Controversy–Professions and Professionalism–Professional Ideals and Virtues–Uses of Ethical Theories.

UNIT II ENGINEERING ASSOCIAL EXPERIMENTATION 9

Engineering as Experimentation–Engineers as responsible Experimenters–Research Ethics – Codes of Ethics–Industrial Standards- A Balanced Outlook on Law–The Challenger CaseStudy.

UNIT III ENGINEER'S RESPONSIBILITY FOR SAFETY 9

Safety and Risk– Assessment of Safety and Risk– Risk Benefit Analysis–Reducing Risk–The Government Regulator's Approach to Risk- Chernobyl Case Studies and Bhopal.

UNIT IV RESPONSIBILITIES AND RIGHTS 9

Collegiality and Loyalty–Respect for Authority–Collective Bargaining–Confidentiality–Conflicts of Interest– Occupational Crime–Professional Rights–Employee Rights– Intellectual Property Rights (IPR) –Discrimination.

UNIT V GLOBAL ISSUES 9

Multinational Corporations– Business Ethics-Environmental Ethics –Computer Ethics-Rolein Technological Development– Weapons Development– Engineers as Managers–Consulting Engineers–Engineers as Expert Witnesses and Advisors–Honesty–Moral Leadership–Sample Code Conduct.

TOTAL : 45 PERIODS

OUTCOMES: After successful completion of the course students able to

1. Apply the ethical theories in engineering environment.
2. Analyze the risks and improve their responsibility for safety.
3. Uutilize their rights and improve responsibilities.
4. Propose remedies for global issues.

TEXT BOOKS:

1.	Mike Martin and Roland Schinzinger,"Ethics in Engineering",McGraw Hill,NewYork(2005).
2.	Charles E Harris, Michael S Pritchardand Michael J Rabins,"Engineering Ethics–Concepts and Cases",Thompson Learning,(2000).
3.	David Ermannand Michele S Shauf,"Computers,Ethics and Society",Oxford University Press,(2003)
REFERENCES:	
1.	*Charles D Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico,1999.*
2.	*John R Boatright, "Ethics and the Conduct of Business", Pearson Education, 2003.*
3.	*Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, 2001.*
4.	*Prof. (Col) PS Bajaj and Dr.Raj Agrawal,"Business Ethics–An Indian Perspective",Biztantra, NewDelhi,2004.*
5.	*David Ermannand Michele S Shauf, "Computers, Ethics and Society",Oxford University Press,2003.*

17PTEPC605	POWER ELECTRONICS LABORATORY	L	T	P	C
		0	0	3	1

OBJECTIVES :

- To provide Experiment test bench to learn the characteristics of power semiconductor devices
- To provide hands on experience with power electronic AC to DC converter and dc to DC converter to determine the control characteristics
- To provide hands on experience with various power electronic inverters design and testing
- To study the characteristics of AC voltage controller and SMPS
- To know the performances of resonant and quasi resonant converter.

LIST OF EXPERIMENTS

1. Characteristics of SCR, TRIAC and DIAC.
2. Characteristics of MOSFET and IGBT.
3. Determination of Control Characteristics of AC to DC fully controlled converter (1-phase and 3-phase).
4. Determination of Control Characteristics of AC to DC half controlled converter (1-phase and 3-phase).
5. Determination of Control Characteristics of Step down and Step up chopper.
6. IGBT based PWM inverter.
7. Series and Parallel inverter.
8. AC Voltage Controller.
9. Switched Mode Power Supply (Fly back, Forward and half Bridge Methods).
10. Performances of Resonant and Quasi Resonant Converter.

TOTAL: 45 PERIODS

OUTCOMES: After successful completion of the course students able to

1.	Design conduct experiment on various converter
2.	Compare the characteristics of various power semiconductor devices.
3.	Demonstrate the operation of phase controlled rectifiers based DC drives.
4.	Analyze the basic topologies of DC-DC converters.
5.	Employ the different modulation techniques of pulse width modulated inverters.
6.	Compute the performance of AC voltage controller.

Semester-VII

17PTEPC701	ENERGY UTILIZATION, CONSERVATION AND AUDITING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on electric drives and traction systems
- To introduce the energy saving concept by different ways of illumination.
- To understand the different methods of electric heating and electric welding.
- To study various energy conservation principles
- To study various energy audit Methodology and its benefits

UNIT I	ELECTRIC DRIVES AND TRACTION	9

Fundamentals of electric drive – choice of an electric motor – application of motors for particular services- traction motors – characteristic features of traction motor-systems of railway electrification- electric braking- train movement and energy consumption- traction motor control-track equipment and collection gear.

UNIT II	ILLUMINATION	9

Introduction-definition and meaning of terms used in illumination engineering-classification of light sources-incandescent lamps, sodium vapour lamps, mercury vapour lamps, fluorescent lamps– design of illumination systems-indoor lighting schemes- factory lighting halls-outdoor lighting schemes-flood lighting- street lighting- energy saving lamps, LED

UNIT III	HEATING AND WELDING	9

Introduction- advantages of electric heating –modes of heat transfer – methods of electric heating-resistance heating-arc furnaces-induction heating-dielectric heating-electric welding–types-resistance welding-arc welding- power supply for arc welding- radiation welding.

UNIT IV	ENERGY CONSERVATION	9

General energy problem-demand supply gap, Scope for energy conservation and its benefits-Energy conservation Principle –energy saving opportunities in electric motors by Power factor improvement-Energy conservations in air conditioners, compressors, fans, electric furnaces, ovens- lighting techniques – Natural , CFL, LED lighting.

UNIT V	ENERGY AUDITING	9

Energy audit and its benefits- Energy flow diagram- Preliminary, Detailed energy audit-Methodology of –Pre audit, audit and post audit- Energy audit report- Electrical Measuring

Instruments: Power Analyser- Combustion analyser, fuel efficiency monitor, thermometer-contact, infrared, pitot tube and manometer, water flowmeter, leak detector, tachometer and luxmeter-IE rules and regulations for energy audit Electricity act.	
	TOTAL : 45 PERIODS
OUTCOMES:	After successful completion of the course students able to
1.	Design traction system
2.	Design indoor and outdoor lightening system
3.	Design different heating and welding Machines.
4.	Apply Energy conservation methods in various loads.
5.	Perform energy audit and prepare the report.
TEXTBOOKS:	
1.	N.V.Suryanarayana,"Utilisation of Electric Power",Wiley Eastern Limited,New Age International Limited,1993.
2.	J.B.Gupta,"Utilisation Electric power and Electric Traction",S.K.Kataria andSons,2000.
3.	Paul O Callaghan,' Energy management' Mcgraw Hill, New Delhi.
REFERENCES:	
1.	*R.K.Rajput, Utilisation of Electric Power, Laxmi publications Private Limited., 2007.*
2.	*H.Partab, Art and Science of Utilisation of Electrical Energy", Dhanpat Rai and Co., New Delhi,2004.*
3.	*C.L.Wadhwa, "Generation, Distribution and Utilisation of Electrical Energy", New Age InternationalPvt.Ltd.,2003.*
4.	*S.Sivanagaraju, M.Balasubba Reddy, D.Srilatha,' Generation and Utilization of Electrical Energy', Pearson Education, 2010.*
5.	*'Fundamentals of electrical system', Bureau of Energy Efficiency.*
6.	*www.bee-india.com*

17PTEEE704	PROJECT WORK	L	T	P	C
		0	0	18	6

OBJECTIVES

- To provide opportunity to explore a problem or issue of particular personal or professional interest.
- To address the problem or issue through focused study and applied research under the direction of a faculty member.
- To synthesize and apply the knowledge and skills acquired in his/her academic program to real-world issues and problems.
- To improve ability to think critically and creatively, to solve practical problems,
- To make reasoned and ethical decisions, and to communicate effectively.

It is intended to start the project work early in the seventh semester and carry out both design and fabrication of an Electrical and Electronic device whose working can be demonstrated. The design is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester.

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews in that any one review will be conducted with external examiner.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 275 PERIODS

OUTCOMES:	On completion of this course, students will be able to
1	Identify the real time Engineering problems in their day to day life.
2	Apply the knowledge and skills acquired in their courses to a specific problem or issue
3	Think critically and creatively to address and help solve these professional or social issues and to further development.
4	Refine research skills and demonstrate their proficiency in written and oral communication skills.
5	Take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.

LIST OF PROFESSIONAL ELECTIVES

17PTEPE001	SOLID STATE DRIVES	L	T	P	C
		3	0	0	3

OBJECTIVES :

- To understand steady state operation and transient dynamics of a motor load system.
- To study and analyze the operation of the converter/chopper fed dc drive, both qualitatively and quantitatively.
- To study and understand the operation and performance of AC motor drives.
- To analyze and design the current and speed controllers for a closed loop solid state DC motors drive.

UNIT I	DRIVE CHARACTERISTICS	9

Electric drive–Equations governing motor load dynamics–steady state stability –multi quadrant Dynamics: acceleration, deceleration, starting & stopping– typical load torque characteristics – Selection of motor

UNIT II	CONVERTER/CHOPPER FED DC MOTOR DRIVE	9

Steady state analysis of the single and three phase converter fed separately excited DC motor drive–continuous and discontinuous conduction–Time ratio and current limit control – 4 quadrant operations of converter / chopper fed drive.

UNIT III	INDUCTION MOTOR DRIVES	9

Stator voltage control-energy efficient drive-v/f control-constant air gap flux – field weakening mod –voltage/ current fed inverter –closed loop control.

UNIT IV	SYNCHRONOUS MOTOR DRIVES	9

V/f control and self- control of synchronous motor: Margin angle control and power factor control– permanent magnet synchronous motor.

UNIT V	DESIGN OF CONTROLLERS FOR DRIVES	9

Transfer function for DC motor / load and converter – closed loop control with Current and speed feedback – armature voltage control and field weakening mode–Design of controllers; current controller and speed controller-converter selection and characteristics.

TOTAL : 45 PERIODS

OUTCOMES:	After successful completion of the course students able to
1.	Design converter/chopper fed dc motor drive
2.	Design induction motor drive
3.	Design synchronous motor drive
4.	Design controllers for drive
TEXT BOOKS:	
1.	GopalK.Dubey,Fundamentals of Electrical Drives,Narosa Publishing House, 1992
2.	Bimal K.Bose.Modern Power Electronics and AC Drives,Pearson Education, 2002
3.	Vedam Subramanyam, "Thyristor Control of Electric Drives", Tata McGraw Hill, 2007
4.	S.K.Pillai, A First course on Electrical Drives, Wiley Eastern Limited, 1993.
REFERENCES:	
1.	*John Hind marshand A lasdain Renfrew,"Electrical Machines and Drives System,"Elsevier 2012*
2.	*Shaahin Felizadeh, "Electric Machines and Drives",CRC Press (Taylor and Francis Group),2013.*
3.	*R.Krishnan, Electric Motor & Drives: Modelling, Analysis and Control, Prentice Hall of India, 2001*

17PTEPE002	ADVANCED CONTROL SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on design in state variable form
- To provide knowledge in phase plane analysis
- To give basic knowledge in describing function analysis
- To study the design of optimal controller
- To study the design of optimal estimator including Kalman Filter

UNIT I	STATE VARIABLE CONTROLLER DESIGN	9

Introduction to state Model- effect of state Feedback- Necessary and Sufficient Condition for Arbitrary Pole-placement- pole placement Design- design of state Observers- separation principle- servo design: -State Feedback with integral control.

UNIT II	PHASE PLANE ANALYSIS	9

Features of linear and non-linear systems - Common physical non-linearities – Methods of linearization Concept of phase portraits – Singular points – Limit cycles – Construction of phase portraits – Phase plane analysis of linear and non-linear systems – Isocline method.

UNIT III	DESCRIBING FUNCTION ANALYSIS	9

Basic concepts, derivation of describing functions for common non-linearities – Describing function analysis of non-linear systems – limit cycles – Stability of oscillations.

UNIT IV	OPTIMAL CONTROL	9

Introduction –Continuous Time Linear State Regulator – Discrete Time Linear State Regulator – Solution of Ricatti's equation.

UNIT V	OPTIMAL ESTIMATION	9

Optimal estimation – Kalman- Bucy Filter-Solution by duality principle-Discrete systems-Kalman Filter.

TOTAL : 45 PERIODS

OUTCOMES:

After successful completion of the course students able to

1. Design in state variable form.
2. Understand the phase plane analysis.
3. Understand the describing function analysis.
4. Design of optimal controller.
5. Design of optimal estimator including Kalman Filter.

TEXT BOOKS:	
1.	M.Gopal, "Digital Control & State Variable Methods", Tata McGraw Hill, 4th EDITION, 2012
2.	I.J. Nagrath and M.Gopal, "Control Systems Engineering", New Age International Publishers, 5th Edition, 2010.
3.	Richard C. Dorf, "Modern control systems",8th Edition, Addison Wesley, 2012.
REFERNCES:	
1.	*K.Ogatta, "Discrete time control system", PHI, 2010.*
2.	*B.C.Kuo," Digital Control Systems", SRL Publication, 1997.*
3.	*M. Gopal, "Control Systems Principles and Design", TATA Mcgraw hill, 3 Edition, 2010*
4.	*M.Gopal," Modern control system theory", New Age International Publishers, 2002*

17PTEPE003	FIBRE OPTICS AND LASER INSTRUMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To expose the students to the basic concepts of optical fibres and their properties
- To provide adequate knowledge about the Industrial applications of optical fibres.
- To expose the students to the Laser fundame.
- To provide adequate knowledge about Industrial application of lasers.
- To provide adequate knowledge about holography and Medical applications of Lasers.

UNIT I	OPTICAL FIBRES AND THEIR PROPERTIES	9

Principles of light propagation through a fibre - Different types of fibres and their properties, fibre characteristics – Absorption losses – Scattering losses – Dispersion – Connectors and splicers – Fibre termination – Optical sources – Optical detectors.

UNIT II	INDUSTRIAL APPLICATION OF OPTICAL FIBRES	9

Fibre optic sensors – Fibre optic instrumentation system – Different types of modulators – Interferometric method of measurement of length – Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain.

UNIT III	LASER FUNDAMENTALS	9

Fundamental characteristics of lasers – Three level and four level lasers – Properties of laser – Laser modes – Resonator configuration – Q-switching and mode locking – Cavity damping – Types of lasers – Gas lasers, solid lasers, liquid lasers, semiconductor lasers.

UNIT IV	INDUSTRIAL APPLICATION OF LASERS	9

Laser for measurement of distance, length, velocity, acceleration, current, voltage and Atmospheric effect – Material processing – Laser heating, welding, melting and trimming of material – Removal and vaporization.

UNIT V	HOLOGRAM AND MEDICAL APPLICATIONS	9

Holography – Basic principle - Methods – Holographic interferometry and application, Holography for non-destructive testing – Holographic components – Medical applications of lasers, laser and tissue interactive – Laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology.

TOTAL : 45 PERIODS

OUTCOMES:	
After successful completion of the course students able to	
1.	Understand the properties of optical fibre.
2.	Measure Electrical quantities in industrial environment
3.	Understand the fundamentals of Laser.
4.	Use Laser for heating and welding in industry
5.	Apply the knowledge of holograms for medical applications for treatment of disease.
TEXT BOOKS:	
1.	J.M. Senior, 'Optical Fibre Communication – Principles and Practice', Prentice Hall of India, 1985
2.	J. Wilson and J.F.B. Hawkes, 'Introduction to Opto Electronics', Prentice Hall of India, 2001
REFERNCES:	
1.	*G. Keiser, 'Optical Fibre Communication', McGraw Hill, 1995.*
2.	*M. Arumugam, 'Optical Fibre Communication and Sensors', Anuradha Agencies,2002*
3.	*John F. Read, 'Industrial Applications of Lasers', Academic Press, 1978*
4. .	*Monte Ross, 'Laser Applications', McGraw Hill, 1968*

17PTEPE004	BIO MEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Introduce Fundamentals of Biomedical Engineering
- To Introduce various bio potential electrodes used in Biomedical Engineering
- To study the heart system and its measurements
- To study the measurement of electrical activity in neuromuscular system and brain
- To have a basic knowledge in life assisting and therapeutic devices

UNIT I	FUNDAMENTALS OF BIOMEDICAL ENGINEERING	9

Brief description of musculoskeletal, endocrine, gastrointestinal, nervous, circulatory and respiratory systems; the nature of bioelectricity, action events of nerve; the origin of bio potentials. Basic components of a biomedical system-Kidney and blood flow - Biomechanics of bone - Biomechanics of soft tissues - Basic mechanics of spinal column and limbs.

UNIT II	BIO POTENTIAL ELECTRODES	9

Signal acquisition; electrodes for biophysical sensing; electrode-electrolyte interface; skin preparation, electrode-skin interface and motion artifact; surface electrodes; microelectrodes; Internal electrodes; electrode arrays; electrodes for electric stimulation of tissues; electrode polarization, electrical interference problems in biopotential measurement; electrical safety.

UNIT III	THE HEART SYSTEM AND ITS MEASUREMENTS	9

The heart; electro conduction system of the heart; the ECG waveform; the standard lead system; the ECG preamplifier; ECG machines; Cardiac monitors; Transient protection; common-mode and other interference-reduction circuits, Measurement of blood pressure, spirometer – Photo Plethysmography, Body Plethysmography, finger-tip oxymeter, measurement of blood pCO2, pO2

UNIT IV	MEASUREMENT OF ELECTRICAL ACTIVITY IN NEUROMUSCULAR SYSTEM AND BRAIN	9

Neuron potential; muscle potential; electromyography (EMG); electroencephalography (EEG); EEG electrodes and the 10-20 system; EEG amplitude and frequency bands; the EEG system – simplified block diagram; preamplifiers and EEG system specifications; EEG diagnostic uses and sleep patterns; visual and auditory evoked potential recordings; EEG system artifacts.

UNIT V	IMAGING, LIFE ASSISTING, THERAPEUTIC AND ROBOTIC DEVICES	9

Computer tomography – MRI – Ultrasonography – Endoscopy ,Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio

meters – Dialysers – Lithotripsy - ICCU patient monitoring system - Nano Robots - Robotic surgery – Advanced 3D surgical techniques- Orthopedic prostheses fixation.	
	TOTAL : 45 PERIODS
OUTCOMES:	After successful completion of the course students able to
1.	Know electrical signal production and its conduction in human body.
2.	Select proper electrode for signal pick up from human body
3.	Trace cardiac waveform and characterise its condition
4.	Trace brain waveform and characterise its condition
5.	Know the different life saving, therapeutic and imaging bio medical systems its importance to patients
TEXT BOOKS:	
1.	Leslie Cromwell, Biomedical Instrumentation and Measurement, Prentice hall of India, New Delhi,2007.
2.	Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.
3.	Khandpur R.S, Handbook of Biomedical Instrumentation, , Tata McGraw-Hill, New Delhi, 2nd Edition, 2003
REFERENCES:	
1.	*John G. Webster, Medical Instrumentation Application and Design, John Wiley and sons, New York, 1998*
2.	*Duane Knudson, Fundamentals of Biomechanics, Springer, 2nd Edition, 2007.*
3.	*Ed. Joseph D. Bronzino, The Biomedical Engineering Hand Book, Third Edition, Boca Raton, CRC Press LLC, 2006.*
4.	*M.Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.*

17PTEPE005	FUNDAMENTALS OF NANOSCIENCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn about basis of nanomaterial science
- To learn about nanomaterial preparation methods
- To learn about basis of nanomaterial science, preparation method and types
- To learn about nanomaterial characterization techniques
- To study various application fields of nano materials

UNITI	INTRODUCTION	9

Nanoscale Science and Technology-Implications for Physics, Chemistry, Biology and Engineering-Classifications of nano structured materials-nano particles-quantum dots,nano wires-ultra-thin films-multi-layered materials.Length Scales in volved and effecton properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties.Introduction to properties and motivation for study (qualitativeonly).

UNITII	GENERAL METHODS OF PREPARATION	9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy,MOMBE.

UNITIII	NANO MATERIALS	9

Nano forms of Carbon-Buckminster fullerene-graphene and carbon nano tube,Single wall carbon Nanotubes(SWCNT)and Multiwall carbon nanotubes(MWCNT)-methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD),structure-property Relationships applications-Nanometal oxides-ZnO, TiO2,MgO,ZrO2, NiO, nano alumina, CaO,AgTiO2,Ferrites, Nano clays- functionalization and applications-Quantum wires,Quantum dots-preparation, properties and applications.

UNITIV	CHARACTERIZATION TECHNIQUES	9

X-ray diffraction technique, Scanning Electron Microscopy- environmental techniques,Transmission Electron Microscopy including high-resolution imaging ,Surface Analysis techniques -AFM,SPM, STM,SNOM,ESCA,SIMS-Nano indentation.

UNITV	APPLICATIONS	9

NanoInfoTech: Information storage- nano computer,molecular switch,super chip,nanocrystal, Nanobiotechlogy:nano probes in medical diagnostics and biotechnology,Nano medicines, Targetted drug delivery,Bioimaging-Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical

Systems(NEMS)-Nano sensors, nano crystalline silver for bacterial inhibition,Nano particles for sunbarrier products- In Photostat,printing,solar cell,battery.	
	TOTAL:45PERIODS
OUTCOMES:	After successful completion of the course students able to
1.	Familiarize about the science of nano material
2.	Demonstrate the preparation of nano material
3.	Develop knowledge in characteristic nano material
4.	Apply Nano Science into the applications
TEXTBOOKS:	
1.	A.S.Edelstein and, R.C.Cammearata,eds.,"Nano materials: Synthesis,Properties and Applications",Institute of Physics Publishing,Bristol andPhiladelphia, 1996
2.	NJohn Dinardo,"Nano scale Charecterisation of surfaces &Interfaces",2nd edition, Weinheim Cambridge,Wiley-VCH,2000.
REFERENCES:	
1.	*G Timp,"Nano technology",AIP press/Springer,1999*
2.	*Akhlesh Lakhtakia,"The Hand Bookof NanoTechnology,Nanometer Structure, Theory,Modeling and Simulations".Prentice-Hall of India(P) Ltd,NewDelhi,2007.*

17PTEPE006	POWER QUALITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the power quality problem
- To educate on production of voltages sags, over voltages and harmonics and methods of control.
- To study overvoltage problems
- To study the sources and effect of harmonics in power system
- To impart knowledge on various methods of power quality monitoring.

UNITI	INTRODUCTIONTOPOWER QUALITY	9

Terms and definitions: Overloading-under voltage-over voltage. Concepts of transients-short duration variations such as interruption-long duration variation such as sustained interruption. Sags and swells-voltage sag-voltage swell-voltage imbalance-voltage fluctuation - power frequency variations. International standards of power quality. Computer Business Equipment Manufacturers Associations (CBEMA) curve.

UNITII	VOLTAGE SAGS AND INTERRUPTIONS	9

Sources of sags and interruptions- estimating voltage sag performance. Thevenin's equivalent source –analysis and calculation of various faulted condition. Voltage sag due to induction motor starting. Estimation of the sag severity- mitigation of voltage sags, active series compensators. Static transfer switches and fast transfer switches.

UNITIII	OVERVOLTAGES	9

Sources of over voltages - Capacitor switching – lightning - ferro resonance. Mitigation of voltage swells - surge arresters - low pass filters - power conditioners. Lightning protection – shielding - line

Arresters - protection of transformers and cables. An introduction to computer analysis tools for transients, PSCAD and EMTP.

UNITIV	HARMONICS	9

Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics- Harmonics Vs transients. Effect of harmonics- harmonic distortion-voltage and current distortion - harmonic indices - inter harmonics – resonance. Harmonic distortion evaluation-devices for controlling harmonic distortion-passive and active filters.

UNITV	POWER QUALITYMONITORING	9

Monitoring considerations - monitoring and diagnostic techniques for various power quality problems - modelling of power quality (harmonics and voltage sag) problems by mathematical simulation tools - power line disturbance analyzer – quality measurement equipment - harmonic / spectrum analyzer - flicker meters -Applications of expert systems for power quality monitoring.	
	TOTAL:45PERIODS
OUTCOMES:	After successful completion of the course students able to
1.	Classify the power quality issues.
2.	Explain IEEE and IEC standards of power quality.
3.	Analyze and mitigate the voltage sag, over voltages and interruptions.
4.	Analyze the harmonic distortion and design the components to reduce harmonics.
5.	Explain power quality monitoring devices.
TEXTBOOKS:	
1.	Roger.C.Dugan, Mark.F.Mc Granagham,Surya Santoso,H.Wayne Beaty,'Electrical Power Systems Quality' McGrawHill,2003.
2.	Edward.F.Fucksand M.A.S.Masoum,"Power Quality in Power System and Electrical Machines," Elsevier Academic Press, 2013.
3.	J.Arrillaga , N.R.Watson, S.Chen,'Power System Quality Assessment',Wiley, 2011.
REFERENCES:	
1.	*G.T.Heydt,'Electric Power Quality', 2nd Edition. (West Lafayette,IN,Starsina Circle Publications,1994).*
2.	*M.H.JBollen,'Understanding Power Quality Problems:Voltage Sags and Interruptions',(New York:IEEEPress, 1999).(For Chapters1,2,3and5)*
3.	*G.J.Wakileh,"Power Systems Harmonics–Fundamentals, Analysis and Filter Design,"Springer 2007.*
4.	*E.Aehaand M.Madrigal, "Power System Harmonics, Computer Modelling and Analysis,"Wiley India,2012.*
5.	*R.S.Vedam, M.S.Sarma,"Power Quality–VAR Compensation in Power Systems," CRC Press 2013.*
6.	*C.Sankaran,'Power Quality',CRC press,Taylor&Francis group,2002.*

17PTEPE007	SPECIAL ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3

OBJECTIVES:	
•	To impart knowledge on the Construction, principle of operation, control and performance of stepping motors.
•	To impart knowledge on the Construction, principle of operation, control and performance of switched reluctance motors.
•	To impart knowledge on the Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors.
•	To impart knowledge on the Construction, principle of operation and performance of Permanent magnet synchronous motors.
•	To impart knowledge on the Construction, principle of operation and performance of Universal, repulsion motors and linear induction motors.

UNIT I	STEPPER MOTORS	9

Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi-stack configurations – Theory of torque predictions – Linear and non-linear analysis – Characteristics – Drive circuits

UNIT II	SWITCHED RELUCTANCE MOTORS	9

Constructional features – Principle of operation – Torque prediction – Power controllers – Non-linear analysis –Inductance Profile- Microprocessor based control – Characteristics.

UNIT III	PERMANENT MAGNET BRUSHLESS D.C. MOTORS	9

Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations – Power controllers – Motor characteristics and control.

UNIT IV	PERMANENT MAGNET SYNCHRONOUS MOTORS	9

Principle of operation – EMF and torque equations – Reactance – Phasor diagram– Power controllers - Converter - Volt-ampere requirements – Torque speed characteristics - Microprocessor based control.

UNIT V	COMMUTATOR MOTORS	9

Construction – Principle of operation- Characteristics – Applications – Universal, repulsion motors and linear induction motors.

	TOTAL : 45 PERIODS
OUTCOMES:	After successful completion of the course students able to
1.	Use stepper motor for various step angle
2.	Control the speed of switched reluctance motor using microprocessor
3.	Control the speed of the BLDC motors using power converters
4.	Control the speed of PM synchronous motor
5.	Identify and characterise commutator motor for applications
TEXT BOOKS:	
1.	K.Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.
2.	T.Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London,1984.
3.	E.G.Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014.
REFERENCES:	
1.	*T.J.E.Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 1989.*
2.	*T.Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984.*
3.	*P.P.Aearnley, 'Stepping Motors–A Guide to Motor Theory and Practice',Peter Perengrinus London, 1982.*
4.	*T.Kenjoand S.Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.*

17PTEPE008	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce quality definitions, quality statements and barriers to TQM
- To facilitate the understanding of Quality Management principles and process.
- To impart knowledge on Total Quality Management tools
- To impart knowledge on Total Quality Management techniques
- To educate on various quality systems and its benefits

UNIT I	INTRODUCTION	9

Introduction-Need for quality- Evolution of quality-Definitions of quality-Dimensions of product and service quality- Basic concepts of TQM-TQM Framework-Contributions of Deming,Juran and Crosby-Barriersto TQM –Quality statements- Customer focus-Customer orientation,Customer satisfaction, Customer complaints,Customer retention- Costs of quality.

UNIT II	TQM PRINCIPLES	9

Leadership-Strategic quality planning, Quality Councils-Employee involvement-Motivation, Empowerment,Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal-Continuous process improvement-PDCA cycle,5S,Kaizen-Supplier partnership-Partnering, Supplier selection, Supplier Rating.

UNIT III	TQM TOOLS AND TECHNIQUES I	9

The seven traditional tools of quality-New management tools- Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT-Bench marking-Reason to benchmark, Benchmarking process- FMEA-Stages, Types.

UNIT IV	TQM TOOLS AND TECHNIQUES II	9

Control Charts- Process Capability-Concepts of Six Sigma-Quality Function Development (QFD)- Taguchi quality loss function - TPM- Concepts, improvement needs-Performance measures.

UNIT V	QUALITY SYSTEMS	9

Need for ISO 9000-ISO9001-2008 Quality System-Elements, Documentation, Quality Auditing- QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors.

	TOTAL:45PERIODS
OUTCOMES:	After successful completion of the course students able to
1.	Explain about TQM Principles
2.	Apply the tools of quality management to manufacturing and services processes
3.	Apply the techniques of quality management to manufacturing and services processes
4.	Understand the concepts of Quality Systems
TEXTBOOKS:	
1.	Dale H.Besterfiled, etat.,"Total quality Management", Pearson Education Asia,Third Edition, Indian Reprint,2006.
REFERENCES:	
1.	*James R.Evans and William M.Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.*
2.	*Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt.Ltd.,2006.*
3.	*Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.*

17PTEPE009	POWER SYSTEM DYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the basics of dynamics and stability problems
- To educate on modeling of synchronous machines
- To educate on the excitation system and speed-governing controllers.
- To study small signal stability of a single-machine infinite bus system with excitation system and power system stabilizer.
- To educate on the transient stability simulation of multi machine power system.

UNIT I	INTRODUCTION	9

Concept and importance of stability in power system operation and design- distinction between transient and dynamic stability-complexity of stability problem in large system-Need for reduced models- stability of interconnected systems.

UNIT II	MACHINE MODELING	9

Park's transformation- flux linkage equations, current space model-per unit conversion-normalizing the equations- equivalent circuit- flux linkage state space model- Simplified models(one axis and constant flux linkage)- steady state equations and phasor diagrams.

UNIT III	MACHINE CONTROLLERS	9

Exciter and voltage regulators- function of excitation systems, types of excitation systems-typical excitation system configuration-block diagram and state space representation of IEEE type1 excitation system-saturation function- stabilizing circuit-Function of speed governing systems-block diagram and state space representation of IEEE mechanical hydraulic governor and electrical hydraulic governors for hydro turbines and steam turbines.

UNIT IV	TRANSIENT STABILITY	9

State equation for multi machine simulation with one axis model-transient stability simulation of multi machine power system with one axis machine model including excitation system and speed governing system using R-K method of fourth order (Gill's technique)-power system stabilizer.

UNIT V	DYNAMIC STABILITY	9

System response to small disturbances- Linear model of the unregulated synchronous machine and its modes of oscillation-regulated synchronous machine- distribution of power

impact- linearization of the load equation for the one machine problem – Simplified linear model-effect of excitation on dynamic stability- approximate system representation-supplementary stabilizing signals- dynamic performance measure- small signal performance measures.	
	TOTAL : 45 PERIODS
OUTCOMES:	After successful completion of the course students able to
1.	Analyse various types of stability
2.	Design synchronous machines based on flux in power system.
3.	Design excitation systems and speed regulation systems
4.	Analyse transient stability and design power system stabilizer.
5.	Analyse the dynamic stability.
TEXT BOOKS:	
1.	Kundur.P, "Power System Stability and Control", McGraw Hill Inc., USA,1994
2.	Anderson.P.M and Fouad.A.A, "Power System Control and Stability" Galgotia Publications, New Delhi, 2003
3.	R.Ramanujam, "Power System Dynamics – Analysis and Simulation", PHI, 2009.
REFERENCES:	
1	*Pai. M.A and Sauer.W, "Power System Dynamics and Stability", Pearson Education Asia, India, 2002.*
2.	*JamesA.Momoh, Mohamed.E.EI-Hawary. "Electric Systems, Dynamics and Stability with Artificial Intelligence applications", Marcel Dekker, USA First Edition, 2000.*
3.	*C.A.Gross,"Power System Analysis,"WileyIndia,2011.*
4.	*B.M.Weedy, B.J.Lory, N.Jenkins, J.B.Ekanayake and G.Strbac," Electric Power Systems",Wiley India,2013.*
5.	*K.Umarao,"Computer Techniques and Models in Power System," I.K.International, 2007.*

17PTEPE010	SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce Non parametric methods
- To impart knowledge on parameter estimation method.
- To impart knowledge on Recursive identification methods
- To impart knowledge on Adaptive control schemes
- To introduce stability, Robustness and Applications of adaptive control method

UNIT I	NON PARAMETRIC METHODS	9

Non parametric methods: Transient analysis–frequency analysis–Correlation analysis–Spectral analysis

UNIT II	PARAMETER ESTIMATION METHODS	9

Least square estimation–best linear unbiased estimation under linear constraints–updating the parameter estimates for linear regression models–prediction error methods: description of prediction methods– optimal prediction – relation between prediction error methods and other identification methods–theoretical analysis- Instrumental variable methods: Description of instrumental variable methods–Input signal design for identification.

UNIT III	RECURSIVE IDENTIFICATION METHODS	9

The recursive least square method –there cursive instrumental variable methods- there cursive prediction error methods–Maximum likelihood. Identification of systems operating in closed loop: Identifiability considerations–direct identification–indirect identification.

UNIT IV	ADAPTIVE CONTROL SCHEMES	9

Introduction –Types of adaptive control–Gain scheduling controller–Model reference adaptive control schemes–Self tuning controller–MRAC and STC: Approaches–The Gradient approach–Lyapunov functions– Passivity theory– pole placement method–Minimum variance control – Predictive control.

UNIT V	ISSUES IN ADAPTIVE CONTROL AND APPLICATIONS	9

Stability– Convergence–Robustness–Applications of adaptive control.

TOTAL:45PERIODS

OUTCOMES:	After successful completion of the course students able to
1.	Apply non parametric methods to control problems
2.	Apply parameter estimation methods to control problems
3.	Apply recursive identification methods to control problems
4.	Apply adaptive control schemes to control problems
TEXTBOOKS:	
1.	Soder Storm T and Peter Stoica, " System Identification", Prentice Hall International, 1989.
2.	Astrom,K.J. and Wittenmark,B.," Adaptive Control",Pearson Education,2nd Edition,2001
3.	Sastry,S. and Bodson,M.," Adaptive Control–Stability,Convergence and Robustness",Prentice Hall inc.,New Jersey,1989.
REFERENCES:	
1.	*LjungL,System Identification:Theoryfor theuser,Prentice Hall,Engle wood Cliffs, 1987.*
2.	*Bela.G.Liptak.,"Process Control and Optimization".,Instrument Engineers' Handbook.,volume 2,CRC press and ISA, 2005.*
3.	*WilliamS.Levine,"Control Systems Advanced Methods,the Control Handbook,CRC Press, 2011.*

17PTEPE011	PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:	
•	To enable the students to study the evolution of Management, to study the functions and principles of management and to learn the application of the principles in an organization.
•	To enable the students to study planning process and planning types.
•	To enable the students to study the organization structure.
•	To enable the students to study the leadership and process of communication.
•	To enable the students to study the System and process of controlling.

UNIT I	INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS	9

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers - managerial roles and skills – Evolution of Management – Scientific, human relations , system and contingency approaches – Types of Business organization - Sole proprietorship, partnership, company-public and private sector enterprises - Organization culture and Environment – Current trends and issues in Management.

UNIT II	PLANNING	9

Nature and purpose of planning – planning process – types of planning – objectives – setting objectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques– Decision making steps and process.

UNIT III	ORGANISING	9

Natureandpurpose–Formalandinformalorganization–organizationchart–organizationstructure–types – Line and staff authority– departmentalization–delegation of authority –centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment,selection,TrainingandDevelopment,PerformanceManagement,Careerplanningandmanagement

UNIT IV	DIRECTING	9

Foundations of individual and group behaviour – motivation – motivation theories – motivational techniques – job satisfaction – job enrichment – leadership – types and theories of leadership – communication – process of communication – barrier in communication – effective communication – communication and IT.

UNIT V	CONTROLLING	9

System and process of controlling – budgetary and non-budgetary control techniques – use of computers and IT in Management control – Productivity problems and management – control and performance – direct and preventive control – reporting.	
	TOTAL : 45 PERIODS
OUTCOMES:	After successful completion of the course students able to
1.	Know how to become manager and differentiate with entrepreneur.
2.	Ability to become a good planner and successively executing the scheme.
3.	Motivate the individuals (workers) to finish the task.
4.	Control the process as leader.
TEXT BOOKS:	
1.	Stephen P. Robbins & Mary Coulter, "Management", Prentice Hall (India) Pvt. Ltd., 10th Edition, 2009.
2.	JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", Pearson Education, 6th Edition,2004
REFERENCES:	
1.	*Stephen A. Robbins & David A. Decenzo & Mary Coulter, "Fundamentals of Management" Pearson Education, 7th Edition, 2011.*
2.	*Robert Kreitner & Mamata Mohapatra, "Management", Biztantra, 2008.*
3.	*Harold Koontz & Heinz Weihrich "Essentials of Management" Tata McGraw Hill,1998*
4.	*Tripathy PC & Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999.*

17PTEPE012	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concept, planning of DC power transmission and comparison with AC Power transmission.
- To analyze HVDC converters.
- To study about the HVDC system control.
- To analyze harmonics and design of filters.
- To model and analysis the DC system under study state.

UNIT I	INTRODUCTION	9

DC Power transmission technology–Comparison of AC and DC transmission–Application of DC transmission–Description of DC transmission system– Planning for HVDC transmission–Modern trends in HVDC technology–DC breakers–Operating problems–HVDC transmission based on VSC–Types and applications of MTDC systems.

UNIT II	ANALYSIS OF HVDC CONVERTERS	9

Line commutated converter-Analysis of Graetz circuit with and without overlap-Pulse number – Choice of converter configuration–Converter bridge characteristics –Analysis of a 12 pulse converters–Analysis of VSC topologies and firing schemes.

UNIT III	CONVERTER AND HVDC SYSTEM CONTROL	9

Principles of DC link control–Converter control characteristics–System control hierarchy–Firing angle control–Current and extinction angle control–Starting and stopping of DC link–Power control– Higher level controllers–Control of VSC based HVDC link.

UNIT IV	REACTIVE POWER AND HARMONICS CONTROL	9

Reactive power requirements in steady state–Sources of reactive power–SVC and STATCOM – Generation of harmonics–Design of AC and DC filters–Active filters.

UNIT V	POWER FLOWANALYSIS IN AC/DC SYSTEMS	9

Per unit system for DC quantities–DC system model–Inclusion of constraints–Power flow analysis Case study.	
	TOTAL:45PERIODS
OUTCOMES:	After successful completion of the course students able to
1.	Understand the concepts of DC transmission Technology
2.	Apply and Analysis of HVDC Converters
3.	Explain about HVDC system control
4.	Explain about Reactive Power control
5.	Explain about Harmonics control
TEXTBOOKS:	
1.	Padiyar,K.R.,"HVDC power transmission system",New Age International (P) Ltd.,NewDelhi, Second Edition,2010.
2.	Edward Wilson Kimbark,"Direct Current Transmission",Vol.I,Wiley interscience,NewYork, London,Sydney,1971.
3.	Arrillaga,J.,"High Voltage Direct Current Transmission",Peter Pregrinus,London,1983.
REFERENCES:	
1.	*KundurP ., "Power System Stability and Control", McGraw-Hill, 1993.*
2.	*Colin Adamson and Hingorani NG,"High Voltage Direct Current Power Transmission",Garraway Limited,London,1960*
3.	*Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering" , New Age International (P)Ltd.,NewDelhi,1990.*

17PTEPE013	POWER SYSTEM TRANSIENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:	
•	To study the importance, casues and effectys of transients
•	To study the generation of switching transients and their control using circuit – theoretical concept.
•	To study the mechanism of lighting strokes and the production of lighting surges.
•	To study the propagation, reflection and refraction of travelling waves.
•	To study the impact of voltage transients caused by faults, circuit breaker action, load rejection on integrated power system.

UNIT I	INTRODUCTION	9

Review and importance of the study of transients-causes for transients. RL circuit transient with sine wave excitation-double frequency transients-basic transforms of the RLC circuit transients. Different types of power system transients- effect of transients on power systems–role of the study of transients in system planning.

UNIT II	SWITCHING TRANSIENTS	9

Over voltages due to switching transients - resistance switching and the equivalent circuit for interrupting the resistor current - load switching and equivalent circuit - waveforms for transient voltage across the load and the switch - normal and abnormal switching transients. Current suppression - current chopping - effective equivalent circuit. Capacitance switching - effect of source regulation - capacitance switching with a restrike, with multiple restrikes. Illustration for multiple restriking transients - ferro resonance.

UNIT III	LIGHTNING TRANSIENTS	9

Review of the theories in the formation of clouds and charge formation-rate of charging of thunder clouds–mechanism of lightning discharges and characteristics of lightning strokes–model for lightning stroke- factors contributing to good line design- protection using ground wires-tower footing resistance- Interaction between lightning and power system.

UNIT IV	TRAVELING WAVES ON TRANSMISSION LINES	9

Computation of transients-transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept- step response- Bewely's lattice diagram-standing waves and natural frequencies- reflection and refraction of travelling waves.

UNIT V	TRANSIENTS IN INTEGRATED POWER SYSTEM	9
The short line and kilometric fault- distribution of voltages in a power system-Line dropping and load rejection- voltage transients on closing and reclosinglines- over voltage induced by faults-switching surges on integrated system Qualitative application of EMTP for transient computation.		
		TOTAL:45PERIODS

OUTCOMES:	After successful completion of the course students able to
1.	Explain the causes and analyse the switching transients
2.	Explain the lightning transients and protection methods.
3.	Explain the effect of travelling waves on transmission lines.
4.	Explain the effect of transient in integrated power system.

TEXTBOOKS:

1.	Allan Greenwood,' Electrical Transients in Power Systems',Wiley Inter Science,NewYork,2nd Edition, 1991.
2.	Pritindra Chowdhari, "Electromagnetic transients in Power System",JohnWileyand SonsInc., SecondEdition,2009
3.	C.S.Indulkar,D.P.Kothari,K.Ramalingam,'Power System Transients–A statistical approach', PHI Learning Private Limited, Second Edition, 2010
4.	R.D. Begamudre, "Extra High Voltage AC Transmission Engineering", NewAge International.

REFERENCES:

1.	*M.S.NaiduandV.Kamaraju,'High Voltage Engineering', Tata McGraw Hill,Fifth Edition,2013.*
2.	*R.D.Begamudre,'Extra High Voltage AC Transmission Engineering',WileyEastern Limited, 1986.*
3.	*Y.Hase,Handbook of Power System Engineering,"Wiley India,2012.*
4.	*J.L.Kirtley, "Electric Power Principles, Sources, Conversion, Distribution and use," Wiley, 2012.*

17PTEPE014	MICRO ELECTRO MECHANICAL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- To educate on the rudiments of Micro fabrication technique
- To introduce various sensors and actuators
- To introduce different materials used for MEMS
- To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

UNIT I	INTRODUCTION:	9

Intrinsic Characteristics of MEMS–Energy Domains and Transducers-Sensors and Actuators – Introduction to Micro fabrication-Silicon based MEMS processes–New Materials–Review of Electrical and Mechanical concepts in MEMS–Semiconductor devices–Stress and strain analysis– Flexural beam bending- Torsional deflection.

UNIT II	SENSORS AND ACTUATORS I	9

Electrostatic sensors–Parallel plate capacitors–Applications–Interdigitated Finger capacitor–Comb drive devices–Micro Grippers–Micro Motors- Thermal Sensing and Actuation–Thermal expansion–Thermal couples–Thermal resistors–Thermal Bimorph- Applications–Magnetic Actuators–Micromagnetic components–Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys

UNIT III	SENSORS AND ACTUATORS II	9

Piezoresistive sensors–Piezoresistive sensor materials- Stress analysis of mechanical elements– Applications to Inertia, Pressure, Tactile and Flow sensors–Piezoelectric sensors and actuators– piezoelectric effects–piezoelectric materials– Applications toInertia, Acoustic, Tactile and Flow sensors.

UNIT IV	MICROMACHINING	9

Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

UNIT V	POLYMERAND OPTICALMEMS	9

Polymersin MEMS–Polimide-SU-8-Liquid Crystal Polymer (LCP) –PDMS–PMMA–Parylene– Fluoro carbon- Application to Acceleration, Pressure, Flow and Tactile sensors-

Optical MEMS– Lenses and Mirrors–Actuators for Active Optical MEMS.	
	TOTAL : 45 PERIODS
OUTCOMES:	After successful completion of the course students able to
1.	Fabricate MEMS devices.
2.	Design sensors and actuators for MEMS.
3.	Do micromachining process.
4.	Apply recent MEMS into physical applications.
TEXT BOOKS:	
1.	Chang Liu,'Foundations of MEMS',Pearson Education Inc., 2012.
2.	Stephen DSenturia, 'Microsystem Design',Springer Publication,2000.
3.	Tai RanHsu,"MEMS& Micro systems Design and Manufacture" Tata McGraw Hill, NewDelhi,2002.
REFERENCES:	
1.	*Nadim Maluf,"An Introduction to Micro Electro Mechanical System Design",Artech House,2000.*
2.	*Mohamed Gad-el-Hak, editor, " The MEMS Handbook",CRC press BacoRaton, 2001.*
3.	*Julian w.Gardner, VijayK.Varadan, OsamaO.Awadelkarim,Micro Sensors MEMS.*
4.	*JamesJ.Allen,Micro Electro Mechanical System Design,CRC Press Publisher, 2005.*
5.	*Thomas M.Adams and Richard A.Layton,"Introduction MEMS,Fabrication and Application,"*

17PTEPE015	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study importance of renewable energy systems in distributed generation
- To analyse and comprehend the various operating modes of solar energy systems and develop maximum power point tracking algorithm
- To analyse and comprehend the various operating modes of wind electrical generators and develop maximum power point tracking algorithm
- To impart knowledge on fuel cell systems
- To Provide knowledge about various hybrid renewable energy systems

UNIT I	INTRODUCTION:	9

Importance of renewable energy, renewable energy systems in distributed power system, Need for Distributed generation, current scenario in Distributed Generation, Planning of DGs.

UNIT II	PHOTOVOLTAIC SYSTEMS AND ITS GRID INTEGRATION	9

Basics of Photovoltaic, Maximum Power Point Tracking (MPPT) techniques, Sizing of stand- Alone PV systems, Inverters for grid-connected PV system: Line commutated, self-commutated with high frequency transformer, central-plant inverter, multiple string inverter, module integrated inverter.

UNIT III	WIND POWER SYSTEMS	9

Basics of wind power, Fixed speed and variable speed wind turbines, storm strategies, MPPT techniques Induction generators, synchronous generators, half scale, full scale and PMSG for wind energy systems, Stand-alone systems, and grid connected wind power systems.

UNIT IV	FUEL CELL SYSTEMS	9

Introduction to fuel cell systems, types of fuel cell systems, Power Electronic Interface of fuel cell systems, Fuel cell/Battery Hybrid systems.

UNIT V	HYBRID RENEWABLE ENERGY SYSTEMS	9

Need for Hybrid Systems- Range and type of Hybrid systems, wind-diesel system, wind-PV system, micro hydro-PV system, biomass-PV-diesel system, PV-Fuel cell hybrid system.

	TOTAL : 45 PERIODS

OUTCOMES:	After successful completion of the course students able to
1.	Apply Distributed generation in existing power systems.
2.	Design PV cell integrated solar power system
3.	Design controllers for wind power systems.
4.	Apply fuel cells in renewable energy integrated power systems.
5.	Design the converter system for hybrid renewable energy sources.
TEXT BOOKS:	
1.	Volker Quaschning, James & James, "Understanding Renewable Energy Systems", Earth scan, 2005.
2.	M.GodoySimoes, Felix A. Farret, "Renewable Energy Systems – Design and Analysis with Induction Generators", CRC press, 2nd edition 2007
3.	Siegfried Heir, "Grid Integration of Wind Energy Systems", John Willey & Sons; 2nd Edition, 2006.
REFERENCES:	
1.	*Mohammed H. Rashid, "Power Electronics Handbook", Elsevier, 2011.*
2.	*.Nick Jenkins, Ron Allan, Peter Crossley, David Kirchen and GoranStrbac, "Embedded Generation" IET Power and Energy series, London-2000.*
3.	*M. P. Kazmierkowski, R. Krishnan, J.D. Irwin, "Control in Power Electronics: Selected Problems", Academic Press; 2002.*
4.	*James Larminie and Andrew Dicks, "Fuel Cell Systems Explained", John Wiley & Sons; 2nd edition, 2003.*

17PTEPE016	FLEXIBLE AC TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the reactive power control techniques
- To educate on static VAR compensators and their applications
- To provide knowledge on Thyristor controlled series capacitors
- To educate on STATCOM devices
- To provide knowledge on FACTS controllers

UNIT I	INTRODUCTION	9

Reactive power control in electrical power transmission lines-Uncompensated transmission line- series compensation–Basic concepts of Static Var Compensator (SVC)–Thyristor Controlled Series capacitor (TCSC)–Unified power flow controller (UPFC).

UNIT II	STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS	9

Voltage control by SVC–Advantages of slope in dynamic characteristics–Influence of SVC on system voltage–Design of SVC voltage regulator–Modelling of SVC for power flow and fast transient stability–Applications: Enhancement of transient stability–Steady state power transfer – Enhancement of power system damping.

UNIT III	THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS	9

Operation of the TCSC–Different modes of operation–Modelling of TCSC–Variable reactance model–Modelling for Power Flow and stability studies. Applications: Improvement of the system stability limit–Enhancement of system damping.

UNIT IV	VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS	9

Static Synchronous Compensator (STATCOM)–Principle of operation–V-I Characteristics. Applications: Steady state power transfer-enhancement of transient stability- prevention of voltage instability. SSSC-operation of SSSC and the control of power flow–modelling of SSSC in load flow and transient stability studies.

UNIT V	CO-ORDINATION OF FACTS CONTROLLERS	9

Controller interactions–SVC –SVC interaction–Co-ordination of multiple controllers using linear control techniques–Control coordination using genetic algorithms.

	TOTAL : 45 PERIODS
OUTCOMES:	After successful completion of the course students able to
1.	Design static VAR compensator
2.	Design TCSC and various Facts controllers
3.	Explain Voltage Source Converter
4.	Explain coordination of multiple controllers
TEXT BOOKS:	
1.	R.Mohan Mathur, RajivK.Varma, "Thyristor –Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley&Sons, Inc,2002.
2.	Narain G.Hingorani, "Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers Distributors, Delhi 2011.
3.	K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International (P) Limited, Publishers, NewDelhi, 2008.
REFERENCES:	
1.	*A.T.John,"Flexible A.C. Transmission Systems",Institution of Electrical and Electronic Engineers(IEEE),1999.*
2.	*V.K.Sood, HVDC and FACTS controllers Applications of Static Converters in Power System, APRIL 2004, Kluwer AcademicPublishers,2004.*
3.	*Xiao Ping Zang, Christian Rehtanz and BikashPal, "Flexible AC Transmission System: Modelling and Control"Springer, 2012*