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B. Tech Electrical and Electronics Engineering

Curriculum

(Credit hrs 157)

(For the students admitted during AY 2019-23

Semester I

Code	Course Name	Core / Elective	L-T-P	Total Cr hrs
EGL 101	Introduction To Communication		3-0-0	3
PHY 101	Introduction To Classical Mechanics		2-0-0	2
PHY 101	Introduction To Classical Mechanics Lab		0-0-2	1
ENG 111	Basic Electronics		3-0-0	3
ENG 111	Basic Electronics Lab		0-0-2	1
MAT111	Single Variable Calculus		3-0-0	3
CSE 102	Introduction To Computer Science and Programming		3-0-0	3
CSE 102	Introduction To Computer Science and Programming Lab		0-0-2	1
CDC 101	CDC-1		1-0-0	1

Semester II

Code	Course Name	Core / Elective	L-T-P	Total Cr hrs
CDC 102	CDC-2		1-0-0	1
BS	BS Elective-1		2-0-2	3
PHY	Electricity and Magnetism		2-0-2	3
ECO	Economics		3-0-0	3
MAT	Probability and Statistics		3-0-0	3
	Creative Thinking (Minerva)			3
MAT 121	Multi Variable Calculus		3-0-0	3
EEE 102	Fundamentals of Electrical Engineering		2-1-0	3

Semester III

Code	Course Name	Core / Elective	L-T-P	Total Cr hrs
EEE 201	Electrical and Electronics Measurement		2-0-0	2
EEE 201	Electrical and Electronics Measurement Lab		0-0-2	1
MAT 131	Differential Equations		3-0-0	3
EEE 202	Electrical Circuit Analysis		2-1-0	3
EEE 202	Electrical Circuit Analysis Lab		0-0-2	1
OE	Open Elective I		3-0-2	4
OE	Open Elective II		3-0-2	4
ENG 101	Fundamentals of Mechanical Engineering		3-0-0	3
	CDC-3/CCC-1		1-0-0	1

Semester IV

Code	Course Name	Core / Elective	L-T-P	Total Cr hrs
	CDC-4/CCC-2		1-0-0	1
HS	Humanities/Social Studies Elective		3-0-0	3
MAT	Linear Algebra		3-0-0	3
OE	Open Elective III		3-0-2	4
EEE 203	Control Systems Design		2-0-0	2
EEE 203	Control Systems Design Lab		0-0-2	1
EEE	UROP		0-0-6	3
EEE 204	DC machines and Transformers		3-0-0	3
EEE 204	DC machines and Transformers Lab		0-0-2	1
ME 211	SolidWorks (Engineering Graphics)		0-0-2	1

Semester V

Code	Course Name	Core / Elective	L-T-P	Total Cr hrs
EEE 301	AC Machines		3-0-0	3
EEE 301	AC Machines Lab		0-0-2	1
OE	Open Elective –IV		3-0-0	3
OE	Open Elective- V		3-0-2	4
EEE 304	Transmission and Distribution		3-0-0	3
EEE 304	Transmission and Distribution Lab		0-0-2	1
EEE 305	Advance Control Systems Design		2-0-0	2
EEE 305	Advance Control Systems Design Lab		0-0-2	1
EEE 303	Technical Elective-I		3-0-0	3
	CDC-5/CCC-3			

Semester VI

Code	Course Name	Core / Elective	L-T-P	Total Cr hrs
EEE 306	Power System Analysis and Control		3-0-0	3
EEE 306	Power System Analysis and Control Lab		0-0-2	1
EEE 307	Technical Elective-II		3-0-0	3
EEE 308	Power Electronics		3-0-0	3
EEE 308	Power Electronics lab		0-0-2	1
EEE 309	Synchronous and Special Machines		2-0-0	2
EEE 309	Synchronous and Special Machines Lab		0-0-2	1
ENG 321	Multi-Disciplinary Design project		0-0-6	3
OE	Open Elective-VI		3-0-0	3
ENV 101	Introduction to Environmental Science		3-0-0	3
	CDC 6/ CCC 4		Total	23

Semester VII

Code	Course Name	Core / Elective	L-T-P	Total Cr hrs
EEE 402	Technical Elective –III		3-0-0	3
TE	Technical Elective-IV		3-0-0	4
TE	Technical Elective-V		3-0-0	3
EEE 403	Power System Protection		3-0-0	3
EEE 403	Power System Protection Lab		0-0-2	1
OE	Open Elective-VII		3-0-0	3
ENG 404	High Voltage Engineering		2-0-0	2
ENG 404	High Voltage Engineering Lab		0-0-2	1

Semester VII

Code	Course Name	Core / Elective	L-T-P	Total Cr hrs
EEE	Project		0-0-18	9

Open Elective-I

Digital Electronics
Thermodynamics

Open Elective-II

Signals and System
Design & Analysis of Algorithm

Open Elective-III

Analog Electronics
Electromagnetic and Wave Propagation
Database Management

Open Elective-IV

Power Plant Engineering
FPGA
Object Oriented programming with-C
EM Theory & Wave Propagation

Open Elective-V

Microprocessor and Microcontroller

Open Elective-VI

Analog & Digital Communication
Operational Research
Numerical methods in Computation

Open elective-VII

Embedded Systems & VLSI

Technical Elective-I

Advanced Control theory
Artificial Neural Networks & Fuzzy Systems

Technical Elective-II

Special Machines
Renewable Energy Sources
Digital Control System
Control of Electric Drives

Technical Elective-III

Electrical machine Design
Computer Techniques in Power Systems
HVDC
System Modeling and Identification
Switched Mode Power Supplies
Electrical Distribution System

Technical Elective-IV

Flexible AC Transmission System (FACTS)
Utilization of Electric Power
Industrial Drives
Power Quality
Smart Electric Grid
EHV AC Transmission

Technical Elective-V

Advanced Power Electronics

Pulsed Power Systems
Non Linear Control System
Resonant & Soft Switching Converters
Programmable Logic Controllers

Semester - 1

Course Code	Course Name	Credit hr	L/T/P
ENL 101	INTRODUCTION TO COMMUNICATION	3	3-0-0

UNIT I RHETORIC AND PUBLIC SPEAKING

Rhetoric, Critical Thinking and Public Speaking; Thinking outside the Box; How to Deliver a Speech; Fundamentals of Persuasion.

UNIT II NONVERBAL COMMUNICATION

Nonverbal Communication; Spatial distance, eye contact and appearances; how nonverbal communication is more important than words.

UNIT III COMMUNICATION AND THE MEDIA

Persuasion and the media; Radio, television, film, social media and the internet; How the media sells ideas, images, products and life styles; Fundamentals of Informative/Scientific Speeches and Research; The Heart of the Speech – Powerful Narratives; The Power of Narrative.

UNIT IV SMALL GROUP COMMUNICATION

Small group communication; Leadership, conflict and persuasion in groups; The importance of small groups in business; Dr. A. Fisher's Fundamentals of Small Groups; Group Problem Solving; Learning to say no – don't say you will when you won't, don't say yes and then don't do it, be true to your word.

Books of Study:

1. Required Book 1. Communication: Principles for a Lifetime. Beebe, Beebe and Ivy, Sixth Edition, Pearson Publishing.
2. Reference Books 1. Qualitative Communication Research Methods (2011) Bryan C. Taylor and Thomas R. Lindlof. Sage Publications, New Delhi, India, 3rd Edition.
3. The Fundamentals of Small Group Communication (2008) Scott A. Myers and Carolyn M. Anderson. Sage Publications, New Delhi, India.

Semester - 1

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
PHY 112	Introduction to Classical Mechanics	Core	2	0	0	2

UNIT I REVIEW OF NEWTONIAN MECHANICS

Review of Scalars, Vectors and Kinematics, Newton's Laws of Motion and applications, Contact Forces, Static Friction, worked examples, Tension and springs, Pushing Pulling and Tension, Solving Pulley Systems.

UNIT II CIRCULAR MOTION

Polar Coordinates, Position and Velocity Vectors, Angular Velocity, Uniform Circular Motion, Direction of the Acceleration, Period and Frequency, Angular Acceleration, Newton’s Second law and circular motion, worked examples.

UNIT III MOMENTUM AND IMPULSE

Momentum and Impulse, Impulse momentum theorem, Conservation of Momentum, Momentum Diagrams, worked examples, Canter of Mass and Motion of the Canter of Mass, Canter of Mass of a Continuous System - Canter of Mass of a Uniform Rod and different objects, Velocity and Acceleration of the Canter of Mass, Reduction of a System to a Point Particle, Canter of Mass Trajectory

UNIT IV WORK, ENERGY AND COLLISION

Kinetic Energy and Work in 1D and 2D, Work by a constant Force, Work by a Non- Constant Force, Work-Kinetic Energy Theorem and related problems, Worked Examples. Conservative and Non-conservative Forces, Potential Energy due to gravity and of a spring, worked examples, Principle of energy conservation and worked examples. Collision and its type, Collision in 1D and worked examples, Collision in 2D and worked examples.

UNIT V RELATIONAL MOTIONS, GRAVITATION

Rotational Motion, Motion of a rigid body and moment of inertia, Parallel and perpendicular axis theorem, Moment of inertia of different objects, Torque and Angular momentum, worked examples. Conservation of angular momentum, rolling motions – conservation of energy. Central forces, Newton's Law of Gravitation, Acceleration due to gravity, Gravitational Potential Energy.

Books of Study

1. University Physics with Modern Physics with Mastering Physics, (12th Edition) - Hugh D. Young, Roger A. Freedman and Lewis Ford (Publisher – Pearson Education)
2. Physics for Scientist and Engineers, Ninth edition (2017) - Raymond A. Serway, John W. Jewett (Publisher - Cengage India Private Limited)

Books of Reference

1. Classical Mechanics (2011) - Herbert Goldstein (Publisher – Pearson Education).
2. Classical Mechanics (2014) - J. C Upadhayaya (Publisher – Himalaya Publishing House)
3. Fundamentals of Physics – Resnick and Halliday (Publisher – Wiley)

Semester - 1

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
ENG 111	Basic Electronics	Core	3	0	2	4

Unit-I BASIC CIRCUITS AND DIODES (9 hours)

Ohm's law, Kirchhoff's current and voltage laws. Review of semiconductor materials, doping. Forward and reverse bias characteristics of PN junction diode, barrier potential, junction capacitance, diode piecewise linear model. Design of half-wave, full-wave, bridge rectifiers with and without filters, positive and negative clipping circuits with and without bias; clamping using PN junction diode.

Unit II BIPOLAR JUNCTION TRANSISTORS (**9 hours**)

Introduction to bipolar junction transistors (BJTs), NPN and PNP types. Study of common-base, common-collector and common-emitter configurations using BJTs including their input and output I-V characteristics. Current and voltage gain, transistor in active, cut-off and saturation regions. Q-point of the transistor.

Unit III FIELD EFFECT TRANSISTOR and OPERATIONAL AMPLIFIER (9 hours)

Introduction to filed effect transistor (FET), operation of junction FET and MOSFET. Characteristics of an operational amplifier, negative feedback, inverting and non-inverting op-amps, integrator and differentiator design using op-amp. Effect of positive feedback, Schmitt trigger circuit. Differential operational amplifier and common-mode rejection ratio.

Unit IV ELECTRONIC FILTERS (**9 hours**)

Low and high frequency noise in electronic circuits, basic low-pass, high-pass, band-pass and band-reject passive filters design using resistor, capacitor and inductor, magnitude and phase response, transfer function, bode plots. Design and analysis of higher order filters. Active filter design using operational amplifier.

Unit V DIGITAL LOGIC FUNDAMENTALS (9 hours)

Number systems: binary, decimal, octal and hexadecimal number systems, number system conversions. Logic gates: AND, OR, NOT, NAND, NOR, X-OR, X-NOR. De Morgan's laws, Karnaugh maps. Basic combinational logic blocks: adder, subtractor.

Textbooks:

1. "Principles of electronics" by V K Mehta & Rohit Mehta, 2010 edition, S Chand and Co. Publisher, ISBN: 9788121924504.
2. "Electronic devices and circuits" by David A. Bell, 2008 edition, Oxford University Press, ISBN: 9780195693409.
3. "Introduction to digital logic design" by John P. Hayes, 1993 edition, Pearson Edition, ISBN: 9780201154610.

References:

1. "Integrated Electronics" by Millman and Halkias, 2nd edition, Tata McGraw Hill, ISBN: 9780074622452.
2. "Pulse, Digital and Switching waveforms" by Millman and Taub, 2011 edition, Tata McGraw Hill, ISBN: 9780071072724.

Semester - 1

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
Resonant & Soft Switching Converters Resonant & Soft Switching Converters Resonant & Soft Switching Converters MAT 112	Single Variable Calculus	Core	3	0	0	3

Unit I: Limit and Continuity: (5 hours)

Limit of a function at a point, One-sided limits, Continuity, Limits involving infinity.

Unit II: Differentiation: (7 hours)

Derivative at a point, Derivative as a function, Product rule, Quotient rule and chain rule, Implicit differentiation, Rolle's Theorem, Mean Value Theorem.

Unit III: Integration: (9 hours)

Area as a limit of finite sums, Definite and indefinite integral, Fundamental Theorem of Calculus, Integration by substitution, Integration by parts, Integration by partial fractions.

Unit IV: Application of Calculus: (10 hours)

Maxima and minima, Concavity and curve sketching, Optimization problems in Physics, Economics & Mathematics, Area between curves, Volumes, Arc length, Moments and centres of mass, Newton's method to find roots.

Unit V: Sequence and Series: (7 hours)

Sequences, Sum of a series, Comparison test, Root test, Ratio test, Leibniz theorem on alternating series, Power series, Taylor's and Maclaurin series. Absolute and conditional convergence.

Recommended Textbook:

1. Thomas' Calculus, 14th Edition, Joel R. Hass, Christopher E. Heil, Maurice D. Weir, 2018.

Reference Books:

1. Introduction to Real Analysis 4th Edition, Robert G. Bartle, Donald R. Sherbert, 2014
2. Calculus and Analytic Geometry, 9th Edition, George B. Thomas, Jr. Ross L. Finney. 2017.

Suggested Grade Distribution

Exam type	**Marks**
Quiz	10
Assignments	10
Mid sem-I	15
Mid sem-II	15
Final exam	50
Total	**100**

Semester - 1

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
CSE 102	Introduction to Computer Science and Programming	Core	3	0	2	4

Unit I Introduction to Python:

Knowledge, Machines, Languages, Types, Variables Operators and Branching -– Core elements of programs: Bindings, Strings, Input/Output, IDEs, Control Flow, Iteration, Guess and Check – Simple Programs: Approximate Solutions, Bisection Search, Floats and Fractions, Newton-Raphson.

Unit II Functions:

Decomposition and Abstraction, Functions and Scope, Keyword Arguments, Specifications, Iteration vs Recursion, Inductive Reasoning, Towers of Hanoi, Fibonacci, Recursion on non-numerics, Files

Unit III Tuples and Lists:

Tuples, Lists, List Operations, Mutation, Aliasing, Cloning – Dictionaries: Functions as Objects, Dictionaries , Example with a Dictionary, Fibonacci and Dictionaries, Global Variables – Debugging: Programming Challenges, Classes of Tests, Bugs, Debugging, Debugging Examples– Assertions and Exceptions, Assertions, Exceptions, Exception Examples

Unit IV Classes and Inheritance:

Object Oriented Programming, Class Instances, Methods Classes Examples , Why OOP, Hierarchies, Your Own Types – An Extended Example: Building a Class, Visualizing the Hierarchy, Adding another Class, Using Inherited Methods, Gradebook Example, Generators

Unit V Computational Complexity:

Program Efficiency, Big Oh Notation, Complexity Classes Analysing Complexity – Searching and Sorting Algorithms: Indirection, Linear Search, Bisection Search, Bogo and Bubble Sort, Selection Sort, Merge Sort

Books of Study

1. Introduction to Computation and Programming using Python, by John Guttag, PHI Publisher, Revised and Expanded version (Referred by MIT)

Books of References

2. Python Programming using problem solving Approach by ReemaThareja, Oxford

University, Higher Education Oxford University Press; First edition (10 June 2017),

ISBN-10: 0199480173

3. Data Structures and Algorithms in Python by Michael T Goodrich and Robertto

Thamassia, Micheal S Goldwasser, Wiley Publisher (2016)

4. Fundamentals of Python first Programmes by Kenneth A Lambert, Copyrighted material

Course Technology Inc. 1st edition (6th February 2009)

Semester - 1

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
CDC-102	Soft Skills -1	Core	1	0	0	1

Unit I Know Thyself 2 Hours

Personality profiling based on the 16 personality types. Assessment of individual personality type.

Unit II Personality Development 4 Hours

Personality construct, The KSAB Model, Components of perception, perceptual errors, perception as a precursor of attitude and behaviour.

Unit III Communication 6 Hours

The 3 Vs of communication: Visual or Kinesics, Vocal (Articulation), Verbal, Active listening, Barriers to listening, GARF (Giving and Receiving Feedback)

Unit IV Presentation Skills 4 Hours

The four Ps of presentation, Handling different types of target audience

Unit V TIME MANAGEMENT & GOAL SETTING 2 Hours

Pressure Cooker (Activity based on Planning, Organizing and Prioritization), Roller Coaster (Activity on setting SMARTER goals, planning & organizing, short & long term goals).

Reference:

1. The Perception of Deception, David Icke, David Icke Books, 2014,
2. Eye and Brain: The Psychology of Seeing, Richard, Langton Gregory, Princeton University Press, 1997
3. Awaken The Giant Within, Anthony Robbins, Pocket Books, 2001

Semester-2

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
CDC-1002	Soft Skills -2	Core	1	0	0	1

UNIT I MOTIVATION **3 Hours**

Soldiers' Walk and The Japanese Fan (Activities on factors of motivation), Steps to ward off de-motivation

UNIT II CREATIVITY & INNOVATION **3 Hours**

Documentary Making: Students would be encouraged to make a ten-minute documentary on various topics to enhance the power of aesthetics and precision. This activity is aimed at creating an interest in research and think out of the box.

UNIT III CRITICAL & LATERAL THINKING **3 Hours**

Fill Me Up, Stimulating Lateral Thinking, the Curious Case of Mary and Kevin (Activities triggering the different types of thinking), and The Creative Collage. Critical and lateral thinking can be inculcated with a structured re programming of the neural pathways. These specially designed activities will enhance critical and lateral thinking

UNIT IV TEAM DYNAMICS **3 Hours**

Story boarding, Frenzy, Come to my Island, Striking Cars, Defend the Egg, Tallest Tower (Activities on the different stages of team building, team communication, coordination and collaboration)

Unit V MINI PROJECT **(2 Hours)**

Individual projects on topics provided by faculties.

Semester-2

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
MAT 121	Multi Variable Calculus	Core	3	0	0	3

Unit I

Three dimensional coordinate system, Vectors, Dot product, Cross Product, Lines and Planes.

Unit II

Functions of several variables, Limits and continuity for them, Partial Derivatives, The Chain Rule, Directional Derivatives, Gradient.

Unit III

Extreme values, Saddle points, Lagrange multipliers.

Unit IV

Double and Iterated integrals, Area by Double Integration.

Unit V

Triple Integrals and Application.

Recommended Text book:

Thomas' Calculus, 14th Edition, Joel R. Hass, Christopher E. Heil, Maurice D. Weir, 2018.

Suggested Grade Distribution

Exam type	**Marks**
Quiz	10
Assignments	10
Mid sem-I	15
Mid sem-II	15
Final exam	50
Total	**100**

Semester-2

Course Code	**Course Name**	**Core/ Elective**	**Credit hr**	**L/T/P**
ECO 122	Economics	C	3	3-0-0

UNIT I Introduction **(7 hours)**

Nature and scope of Economics, Principles of Economics, Production Possibility Frontier, opportunity Costs, Comparative Advantage and Scope for Trade. Demand and Supply curves, Equilibrium, Shift in curve versus movement along the curve, Elasticity of Demand and Supply. Changes in equilibrium in response to policy changes, income, tastes and supply “shocks”

UNIT II Consumer Behaviour **(6 hours)**

Consumer preferences and Indifference curve analysis – substitution, income and price effect.

UNIT III Production and cost (8 hours)

Production, short- run production function and returns to factor – Average-marginal relationship, long – run production function and laws of return to scale- role of technology. Cost function and cost structure of a firm in the short- run, long run cost function and cost structure.

UNIT IV Types of markets (7 hours)

Perfect competition including shutdown and break-even points. Monopoly. Monopolistic competition and product differentiation.

UNIT V Equilibrium in the short, medium and long run (10 hours)

Short-run equilibrium: The Goods market, the money market and General equilibrium (IS-LM) Medium-run equilibrium: The labour market General Equilibrium (AD-AS) Long-run equilibrium: Introduction to growth, capital accumulation and growth, technological progress and growth.

Unit VI The open economy (International trade) (7 hours)

Openness in goods and financial markets, the goods market, the financial markets and General equilibrium. Exchange rate regime.

Books of study:

1. Principles of microeconomics, N. Gregory Mankiw, Publisher: Cengage Learning fifth edition,

2. Macroeconomics, Oliver Blanchard and David R Johnson, Publisher: Pearson; 6th edition

Books of reference:

1. Intermediate Microeconomics: A Modern Approach, Hal R. Varian, Affiliated EastWest Press Pvt. Ltd., 8th edition.

2. Principles of Macroeconomics with CourseMate, N. Gregory Mankiw, Cengage India, 6th edition.

Semester II

Course code	Course name	Course type	L-T-P-C
MAT - 221	Probability & Statistics	Core	3-0-0-3

Unit I (9 hours)

Basic principle of counting, permutations, combinations, multinomial coefficients, sample space and events, axioms of probability, sample spaces having equally likely outcomes, Conditional probability, Bayes` theorem, independent events.

Unit II (9 hours)

Random variable, discrete random variable, expected value, expectation of a function of a random variable, variance, discrete probability distributions- Bernoulli, Binomial, Poisson, Geometric, negative Binomial distributions, expected value of sums of random variables, cumulative distribution function and its properties.

Unit III (7 hours)

Continuous random variables, expectation and variance – their properties, continuous probability distributions – uniform, normal, exponential distributions, distribution functions.

Unit IV (9 hours)

Joint distribution functions, independent random variables and their sums, conditional distributions, joint probability distribution of functions of random variables, covariance, correlation

Unit V (9 hours)

Definition of statistics, population and sample, representative sample, descriptive statistics – classification and tabulation of univariate data, graphical representation, frequency curves.

Textbooks:

1. Sheldon Ross, A First course in probability (Ninth edition)
2. Michael Baron, Probability and Statistics for computer scientists

Semester-2

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE102	Fundamentals of Electrical Engineering	Core	2	1	0	3

Unit-1

D C circuits: Ohm's Law, Kirchhoff's Laws, Concept of Node, Path, Loop, Branch, Mesh, Ideal and Practical Voltage and Current Source, Voltage and Current Division, Source Transformations, Mesh and Nodal Analysis, Super node and Super mesh Analysis-with Independent Voltage and Current Sources, Illustrative examples.

Unit-2

Electromagnetism: Review of field around a conductor and coil, magnetic flux and flux density, magneto motive force and magnetic field intensity, reluctance and permeability, analysis of magnetic circuit and basic analogy between electric and magnetic circuits.

Electromagnetic Induction: Faraday's law of electromagnetic induction, Fleming's right hand and left hand rule, Lenz's Law, Statically and dynamically induced EMF. Self-inductance, mutual inductance and coefficient of coupling. Inductors in series and parallel, Energy stored in magnetic field.

Electrostatics: Laws of Electrostatics, Electric field, Composite dielectric capacitors, Capacitors in series and parallel, Energy stored in capacitors. Illustrative examples.

Unit-3

Single-phase AC circuits: Generation of sinusoidal voltage, frequency of generated voltage, definition and numerical values of average value, root mean square value, form factor and peak factor of sinusoidally varying quantities, phasor representation of alternating quantities. Analysis, with phasor diagrams, of series R, L, C, R-L, R-C and R-L-C circuits and, Real power, reactive power, apparent power and power factor, concept of resonance. Illustrative examples.

Unit-4

Three Phase Circuits: Necessity and advantages of three phase systems, generation of three phase power. Definition of Phase sequence, balanced supply and balanced load. Relationship between line and phase values of balanced star and delta connections. Power in balanced three-phase circuits, measurement of power by two-wattmeter method. Determination power factor using wattmeter readings. Illustrative examples.

Unit-5

DC Machines & Single Phase Transformers:

DC machines: Operation of DC motor, Back EMF, Torque equation. Types of DC motors, Series, Shunt, Separately Excited, Characteristics and Applications. Significance of back EMF. Illustrative examples.

Single Phase Transformers: Necessity of transformer, Principle of operation and construction of single phase transformers (core and shell types). EMF equation, losses, various losses with respect to load, efficiency, Condition for maximum efficiency, Voltage regulation and its significance. Illustrative problems.

Recommended Books

Text Books:

1. Electrical Engineering Fundamentals, Vincent Del Toro, Second Edition, PHI.

2. Fundamentals of Electrical Engineering, Second edition, Leonard S. Bobrow, Oxford University press, 2011

3. Introduction to Electric Circuits, Richard C. Dorf and James A. Svoboda, Wiley India Private Limited, Sixth Edition, 2007.

4. A Textbook of Electrical Technology, B.L. Theraja and A.K Theraja, S.Chand and Co. Ltd., 2000.

5. Electrical Machinery, P S Bimbra,7th Edition, Khanna Publishers

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
PHY	Electricity and magnetism		2	0	2	3

UNIT I: INTRODUCTION TO VECTOR ALGEBRA

Gradient, Divergence and curl and their physical significances, Gauss and Stokes theorems, Vector operators in different coordinate (Curvilinear, Cartesian, Cylindrical and spherical) systems

UNIT II: ELECTROSTATICS

Coulomb's law, Gauss law, Electric field, Electrostatic Potential, Potential energy of system of charges, Boundary Value problems in electrostatics-solution of Laplace equation in Cartesian system, Method of image charge.

UNIT III: DIELECTRICS AND POLARIZATION

Electric dipole and dipole moment, Electric potential due to dipole, Electric field intensity due to dipole, Polarization P, Electric displacement D, Electric susceptibility and dielectric constant, Bound volume and surface charge densities, Electric field at an exterior and interior point of dielectric.

UNIT IV: MAGNETOSTATICS

Biot-Savart law, Ampere's law for force between two current carrying loops, Ampere's circuital law, Equation of continuity, Magnetic vector potential A, Energy density in magnetic field, magnetization of matter (B, H, M) Magnetic susceptibility and permeability, Hysteresis loss, B-H curve, Diamagnetic, paramagnetic and ferromagnetic substances.

UNIT V: INTRODUCTION TO ELECTRODYNAMICS

Time varying fields: Faradays law of induction, generalization of Amperes' law, Maxwell's equation (Differential and Integral form), Wave equation and plane waves in free space

Books of Study:

1. MIT-- 8.02X online course material

2. Introduction to Electrodynamics (4rd Edition) - David J. Griffiths (Publisher - PHI Learning, Eastern Economy Editions, 2012)

3. Electricity and Magnetism (Reprints 2007, 1st Edition 2001) A. S. Mahajan, A. A.Rangwala, (Publisher - McGraw-Hill Education)

References:

1. Electricity and magnetism Edward M Purcell, David J Morin, 3rd edition, Cambridge University, 2013

2. Classical Electrodynamics (3rd Edition) - John David Jackson (Publisher – Wiley)

Semester-3

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE201	Electrical and Electronics Measurement	Core	2	1	0	3

Unit -1 Fundamentals of measurement

Introduction to measurement and instrumentation, Classification of instruments, Definition of accuracy, precision, resolution. Errors in measurement, classification of errors, Illustrative examples

Unit -2 Analog Instrument and Measurements

General features, construction and torque equation of moving coil, moving iron, electrodynamometer, principle of operation of electrodynamic wattmeter, power measurements construction, theory and operation of AC energy meter, induction type energy meter, testing of energy meter

Unit -3 Instrument Transformers

Advantages of instrument transformer, principle and operation of current and potential transformer

Unit-4 Bridges and Potentiometer

Principle, operation and application of Crompton' DC potentiometer, classification and measurement of resistance - Wheatstone's bridge, Kelvin's double bridge, measurement of inductance-Maxwell's bridge, measurement of capacitance and loss angle-De Sauty's bridge

Unit-5 Oscilloscopes and Mustimeters

General features, construction of cathode ray oscilloscope, measurement of voltage and current, measurement of phase and frequency (Lissajous Patterns), Digital Voltmeters(DVMs) and types of DVMs

RECOMMENDED BOOK(S)
Text Books:

1. A Course in Electrical and Electronic Measurements and Instrumentation, A.K. Sawhney,19th Revised Edition, Dhanpat Rai & Co.

2. Electrical Measurements and Measuring Instruments, E.W.Golding and F.C.Wides,3rd Edition, Wheeler Publishing

3. Electrical and Electronic Measurement and Instrumentation, R.K. Rajput,4th Edition, S.Chand

Reference Books:

1. Electrical Measurement Analysis, Ernest Frank, McGraw Hills, Latest Edit

Semester-3

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
MAT 131	Differential Equations	Core	3	0	0	3

UNIT-1 First Order Differential Equations:

Geometric meaning of $y' = f(x, y)$, Direction Fields, Euler's Method, Classification of ODEs (Linear, Non-linear, Exact, Separable), Integrating Factor, Bernoulli Equations, Initial Value Problem, Modelling (Population Dynamics, Radioactivity, Subsonic Flight).

UNIT-2 Second and Higher Order Linear ODEs:

Homogeneous Linear ODEs, Modelling of Free Oscillations of a Mass-Spring System, Euler-Cauchy Equations, Non-homogeneous ODEs, Variation of Parameters, Modelling (Forced Oscillations. Resonance, Electric Circuits),

UNIT-3 System of ODEs:

Modelling Engineering problems (Electric Network, Mixing problem in two tanks etc.) as systems of ODEs, Wronskian, Phase-Plane Method, Critical Points & Stability, Qualitative Methods for Nonlinear Systems, Nonhomogeneous Linear Systems of ODEs.

UNIT-4 Series Solutions of ODEs:

Introduction to power series method, Legendre's equation & polynomials, Fresenius Method, Bessel's Equations & Functions.

UNIT-5 Laplace Transforms:

Laplace transforms of standard functions, Shifting Theorems, Transforms of derivatives and integrals, Unit step function, Dirac's delta function, Inverse Laplace transforms, Convolution theorem (without proof). Application: Solutions of ordinary differential equations using Laplace transforms.

Book of Study:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. Mary L. Boas, *Mathematical Methods in Physical Sciences*, 3rd Edition, Wiley-India.
3. G. F. Simmons, *Differential Equation with Applications and Historical Notes*, TATA McGraw Hill.
4. S. Vaidyanathan, *Advanced Applicable Engineering Mathematics*, CBS Publishers.

Semester-3

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE202	Electrical Circuit Analysis	Core	2	1	0	3

Unit 1-Basic circuit analysis

Network Reduction Technique using Star–Delta Transformation, analysis of electric circuits with dependent sources: voltage dependent voltage source, voltage dependent current source, voltage dependent voltage source, current dependent current source and current dependent and voltage source.

Unit 2- Two Port Networks

Two Port Networks, Admittance Parameters, Impedance Parameters, Hybrid Parameters and Transmission Parameters. Illustrative examples.

Unit 3- Network theorems with both DC and AC source

Superposition Theorem, Thevinin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Reciprocity Theorem, Millman's Theorems--with Independent and Dependent Voltage and Current Sources. Illustrative examples.

Unit 4- Transient analysis of circuits

Step Response of a Series RL, RC (First Order System) and RLC Circuit (Second Order System) under DC Source Excitation--Time Constant, Rise Time, Peak Time, Peak Overshoot/Undershoot and Settling Time. Principle of Duality. Transient Response Analysis of Series RL, RC and RLC Circuits with AC Source Excitation. Illustrative examples.

Unit 5- Graph theory and Passive Filters

Graph theory- Concept of Tree, Branch, Tree link, Incidence matrix, Tie-set matrix and loop currents, Cut set matrix and node pair potentials. Principle of Duality, Illustrative Examples

Passive filters-Concept-Ideal and practical, properties and uses and classification of filter, concept of low pass and high pass filter using reactive elements. Illustrative examples.

Text Book:

1. Charles K Alexander and Mathew N O Sadiku, “Fundamentals of Electric Circuits”, Tata McGraw-Hill, 3rd Ed, 2009.

2. Abhijit Chakrabarti, “Circuit Theory Analysis and Synthesis”, Dhanpat Rai & Co.; Seventh - Revised edition 2018.

Reference Books:

1. James S. Kang, “Electric Circuits”, Cengage India 2016.

2. Robert L. Boylestad, “Introductory Circuit Analysis”, 12th Edition, Pearson, 2018.

Semester-3

Course: **Electrical Circuit Analysis Lab**

Course code: **EE202** Credits:1 L-T-P: 0-0-2

Laboratory Experiments:

1. To verify Kirchoff's laws.
2. To verify Thevenin's theorem.
3. To verify Superposition theorem.
4. To verify Reciprocity theorem.
5. To verify Norton's theorem.
6. To verify Maximum Power transfer.
7. To study the V-I characteristics of an incandescent lamp.
8. To study and verify the transient behavior of DC network with RL load using MATLAB.
9. To study and verify the transient behavior of DC network with RC load using MATLAB.
10. To study and verify the transient behavior of DC network with RLC load using MATLAB.
11. Measurement single phase power by using three ammeter method.
12. Measurement the single phase power by using three voltmeter method.
13. Measurement of Three Phase Power by Two-Wattmeter Method

Semester-3

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
ENG 101	**Fundamentals of mechanical Engineering**	Core	3	0	0	3

Unit I

Sources of Energy, Types of Prime Movers, Force, Mass, Pressure, Work, Power, Energy, Heat, Temperature, Internal Energy, Enthalpy, Efficiency, Zeroth Law, First Law, Thermodynamic System, Different Types of Fuels, Non-Conventional Energy - Wind, Solar, Bio, Global Warming.

Unit II

Introduction - Fluids, Physical Properties of Fluids, Relationship between Stress and Strain-Rate for Newtonian and Non-Newtonian Fluids, Description of Fluid Flow, Classification of Flows-Laminar and Turbulent Flows, Measurement of viscocity.

Unit III

Heat Engines - External, Internal, Carnot, Rankine, Otto, Diesel Cycles; Steam Boilers - Fire Tube, Water Tube Boilers, Valves; IC Engine - Components, 2 Stroke, 4 Stroke, Engine Performance, Efficiency.

Unit IV

Pumps- Reciprocating, Rotary, Pump Efficiency; Air Compressors-Reciprocating/Rotary; Refrigeration and Air Conditioning- Principles of Working; Brakes, Clutches and Couplings, Drives-Transmission of Power- Belt Drive, Gear Drive, Chain Drive.

Unit V

Mechanics of Materials- Engineering Materials, Material Properties- Tensile Strength, Toughness, Malleability, Hardness, Ductility, Stiffness, Brittleness, Elasticity, Plasticity, Creep, Fatigue, Failure, Stress-strain plots, failures

SEMESTER IV

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
CDC-204	Quantitative and Verbal Ability		1	0	0	1

UNIT I QUANTITATIVE REASONING

Speed, Time and work, Powers and roots, Pipes, cisterns. Problems on Clock, Calendar and Cubes, Height and Distance, Logarithms

UNIT II NON-VERBAL REASONING

Alpha-numerical sequence puzzle, Symbols and their relationships, Blood Relations, Seating Arrangement, Coding-Decoding, Input- Output, test Direction Sense Test,

UNIT III DATA ANALYSIS AND INTERPRETATION

Graphical and Numerical Methods for Describing Data, Interpretation of data in tables and graphs, Permutations and Venn diagrams Counting Methods, Probability.

UNIT IV VERBAL ABILITY

Conditionals, Tense Forms, Verb Forms,

UNIT V VERBAL ABILITY

Phrasal Verbs, Cohesion and Coherence

TEXT BOOK:

1. R.S. Agarwal, A Modern Approach to Verbal & Non Verbal Reasoning, S. Chand Publication
2. P. Anand, Quantitative Aptitude, Wiley, 2015

SEMESTER IV

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
MAT 131	Linear Algebra	Core	3	0	0	3

Unit I – MATRICES AND GAUSSIAN ELIMINATION (9 hours)

Introduction, Geometry of Linear Equations, Gaussian Elimination, Matrix Notation and Matrix Multiplication, Triangular Factors and Row Exchanges, Inverses and Transposes.

Unit II- VECTOR SPACES (11 hours)

Vector spaces and Subspaces, Solving Ax=0 and Ax=b, Linear Independence, Basis and Dimension, The Four Fundamental Subspaces, Graphs and Networks, Linear Transformations.

Unit III – ORTHOGONALITY (9 hours)
Orthogonal Vectors and Subspaces, Cosines and Projections onto Lines, Projections and Linear Squares, Orthogonal Bases and Gram-Schmidt.

Unit IV – DETERMINANTS (7 hours)

Introduction, Properties of the Determinant, Formulas for the Determinant, Applications of Determinants.

Unit V – EIGENVALUES AND EIGENVECTORS (9 hours)

Introduction, Diagonalization of a Matrix, Difference Equations and Powers A^k, Differential Equations and e^{At}, Complex Matrices, Similarity Transformations.

Text Book: G. Strang, Linear Algebra and Its applications, Nelson Engineering, 4th Edn., 2007

Reference Books:

1. S. Axler, Linear Algebra Done Right, 2nd Edn., UTM, Springer, Indian edition, 2010.
2. K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall of India, 1996

SEMESTER IV

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE-204	Electrical machines-I	CORE	3	0	2	4

Unit-I Magnetic fields and magnetic circuits (6 Hours)

Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savant Law; Visualization of magnetic fields produced by a bar magnet and a current Carrying coil - through air and through a combination of iron and air; influence of highly Permeable materials on the magnetic flux lines.

Unit -II: Electromagnetic force and torque (9 Hours)

B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency

Unit-III: DC machines (8 Hours)

Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per Pole, induced EMF in an armature coil. Armature winding and commutation – Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

Unit-IV: DC machine - motoring and generation (7 Hours)

Armature circuit equation for motoring and generation, Types of field excitations – separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines

Unit -V: Transformers (12 Hours)

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses Three-phase Transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers

Text / References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill

Education, 2013.

2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS

Publishers, 2004.

3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.

4. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.

SEMESTER IV

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
ME 211	Introduction to Solidworks	Core	0	0	2	1

Unit 1

GUI familiarity, features, commands, shortcuts, mouse features, drop down menus etc

Unit 2

Sketch entities, Inference line, centerline, line, circle, arc, ellipse, rectangle, slots, polygon, spline, points, text, snap, grid Sketch tools Fillet, chamfer, offset, trim, extend, mirror, copy, rotate, scale, sketch

Unit 3

Blocks, create blocks, add/remove, explode, relations, dimensioning

Unit 4

Part modeling, extrude, revolve, swept, loft, reference, curves, fillet, pattern

Unit 5

Assembly modeling, mating, manipulating components

Unit 6

Surface modeling tools

Unit 7

All views of the object, dimensions

Drafting tools

Unit 8

Simulation express, stress-strain analysis

References

Solidworks user manual

Semester-V

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE-301	AC Machines	CORE	3	0	2	4

Unit-I: Fundamentals of AC machine windings (8 Hours)

Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoid ally distributed winding, winding distribution factor

Unit-II: Pulsating and revolving magnetic fields (4 Hours)

Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

Unit-III: Induction Machines (12 Hours)

Construction, Types (squirrel cage and slip ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly Fed Induction Machines.

Unit-IV: Single-phase induction motors (6 Hours)

Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications

Unit-5: Synchronous machines (10 Hours)

Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine – two

reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

Text/References:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.

2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.

3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.

4. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

5. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.

6. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.

Semester-V

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE 304	Power system-I	CORE	3	0	2	4

Unit-I Supply Systems (6 hours)

Electric supply system, Typical AC power supply Scheme, Comparison of DC and AC transmission, Advantages of high transmission voltage, Various system of power transmission, Comparison of conductor material in overhead system, Comparison of conductor material in underground system, Comparison of various systems of transmission, Elements of a transmission line, Economics of power transmission, Economical choice of conductor size, Economic choice of transmission voltage, Requirement of satisfactory electric supply.

Unit-II: Mechanical Design of Transmission Lines: (6 hours)

Main components of over head lines, Conductor materials, Line supports, insulators, Types of insulators, Potential distribution over suspension insulators, String efficiency, Methods of improving string efficiency, Sag in over head lines and sag calculations.

Unit-III: Inductance and Resistance of Transmission Line: (8 hours)

Introduction, Definition of Inductance, Flux Linkages of an isolated current carrying conductor,

Inductance of a single phase two wire line, Conductor types, Flux Linkages of one conductor in group, Inductance of composite conductor lines, Inductance of three phase lines, Double circuit three phase lines, Bundled conductors, Resistance, Skin effect and Proximity effect, Magnetic field induction.

Unit-IV: Capacitance of Transmission Lines: (6 hours)

Introduction, Electric field of a long straight conductor, Potential difference between two conductors of a group of parallel conductors, Capacitance of a two wire line, Capacitanceof a three phase line with equilateral spacing, Capacitance of a three phase line with unsymmetrical spacing, Effect of earth on transmission line capacitance, Method of GMD, Bundled conductors, Electrostatic induction.

Unit-V: DC and AC distribution: (6 hours)

Distribution system, classification of Distribution systems, AC distribution, DC distribution, Connection scheme of distribution system, Types of DC distributors, DC distribution calculations, DC distributor fed at one end, uniformly loaded distributor fed at one end, distributor fed at both ends, Distributor with both concentrated and uniform loading, Ring distributor, Ring main distributors with interconnector, AC distribution calculations, Methods of solving AC distribution

problems, 3-phase unbalanced loads – 4 wire, Star connected unbalanced loads, Ground detectors.

Unit-VI: Representation of power system component: (6 hours)

Introduction, Single phase Representation of balanced three phase networks, The one line diagram and impedance or reactance diagram, Per unit system, Advantages of pu system, Per unit representation of a transformer, Per unit impedance diagram of a power system, Complex power, The steady state model of synchronous Machine, Power factor and power control, Salient pole synchronous generator, Loading capability diagram [3], Power transformer, Transmission of electric power, System protection , Representation of load.

Unit-VII: Underground cables:

Underground cables, Construction of cables, Classification of cables, Cables for three phase services, Insulation resistance of a single core cable, Capacitance of a single core cable, Dielectric stresses in a single core cable, Most economical conductor size in a cable, Grading of cables, Capacitance grading and inter sheath grading, Capacitance of threecore cable and measurement of capacitance.

Reference Books:

1. Modern Power System Analysis by D P Kothari and I J Nagrath : Fourth Edition: McGraw Hill
2. Principles of Power System by V.K.Mehta and RohitMehta : Reprint 2014 : S. Chand [1,
3. Power Systems Analysis : John J. Grainger and W. D. Stevenson Jr., Tata McGrawHill International.
4. Electrical Power systems: C. L .Wadhwa, 5th Edition, New Age InternationalPublishers.
5. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
6. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
7. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
8. . B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 201

SEMESTER V

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE 305	Advanced control systems design	CORE	2	0	2	3

Unit-I: Model Based Controller Design (10 hours)

Introduction, Control structures and performance measures, Time and frequency domain performance measures, Design of controller, Design of controller for SISO system, Controller design for TITO processes, Limitations of PID controllers, PI-PD controller for SISO system PID-P controller for Two Input Two Output system, Effects of measurement noise and load 1

Unit-II: Frequency Domain Based Identification (4 hours)

Identification of dynamic models of plants, Relay control system for identification, Off-line identification of process dynamics, On-line identification of plant dynamics 1

Unit-III: Time Domain Based Identification (20 hours)

State space based identification, State space analysis of systems, State space based identification of systems, Identification of simple systems, Identification of FOPDT model, Identification of second order plus dead time model, Identification of SOPDT model, Steady state gain from asymmetrical relay test, Identification of SOPDT model with pole multiplicity**,** Existence of limit cycle for unstable system, Identification procedures , Identification of underdamped systems Off-line identification of TITO systems, On-line identification of TITO systems, Review of time domain based identification, DF based analytical expressions for on-line identification, Model parameter accuracy and sensitivity, Improved identification using Fourier series and wavelet

Transform, Reviews of DF based identification.

Unit-IV: Design of Controllers (6 hours)

Advanced Smith predictor controller, Design of controllers for the advanced Smith predictor Model-free controller design, Model based PID controller design, Model based PI-PD controller design, Tuning of reconfigurable PID controllers

References:

1. S. Majhi,Advanced Control Theory-Relay Feedback Approach, Cengage Asia/India Pvt.Ltd, 2009.
2. A. Johnson and H. Moradi, New Identifications and Design Methods,Springer - Verlag, 2005.
3. Norman S. Nise, Control Systems Engineering, John Wiley & Sons, 2008.

SEMESTER VI

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE 306	Power system-II	CORE	3	0	2	4

Unit-I: Power Flow Analysis (7 hours)

Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of nonlinear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.

Unit-II: Stability Constraints in synchronous grids (8 hours)

Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three--phase fault. Analysis using numerical integration of swing equations (using methods like Forward Euler, Runge-Kutta 4th order methods), as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation. Effect of generation rescheduling and series compensation of transmission lines on stability.

Unit-III: Control of Frequency and Voltage (7 hours)

Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power byvarious components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Tap Changing Transformers. Power flow control using embedded dc links, phase shifters and

Unit-IV: Monitoring and Control (6 hours)

Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems. State-estimation. System Security Assessment. Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis.

Preventive Control and Emergency Control.

Unit-V: Power System Economics and Management (7 hours)

Basic Pricing Principles: Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services. Regulatory framework.

Text/References:

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
3. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.
5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.

SEMESTER VI

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE 308	Power electronics	ELECTIVE	3	0	2	4

Unit-II: Power switching devices (8Hours)

Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

Unit-II: Thyristor rectifiers (7Hours)

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

Unit- III: DC-DC buck converter (5Hours)

Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Unit-IV: DC-DC boost converter (5Hours)

Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Unit-V: Single-phase voltage source inverter (10Hours)

Power circuit of single-phase voltage source inverter, switch states and instantaneous outputvoltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage

Unit-IV: Three-phase voltage source inverter (8Hours)

Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation

Text/References:

1. M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India, 2009.

2. N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.
3. R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2007.
4. L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.

SEMESTER VI

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE 309	Synchronous and Special Machine	ELECTIVE	3	0	2	4

UNIT – I Synchronous Machine & Characteristics:

Constructional Features of round rotor and salient pole machines – Armature windings – Integral slot and fractional slot windings; Distributed and concentrated windings – distribution, pitch and winding factors – E.M.F Equation. Harmonics in generated EMF – suppression of harmonics – armature reaction - leakage reactance – synchronous reactance and impedance – experimental determination - phasor diagram – load characteristics.

UNIT – II Regulation of Synchronous Generator:

Regulation by synchronous impedance method, M.M.F. method, Z.P.F. method and A.S.A. methods – salient pole alternators – two reaction analysis – experimental determination of Xd and Xq (Slip test) Phasor diagrams – Regulation of salient pole alternators.

UNIT – III Parallel Operation of Synchronous Generator:

Synchronizing alternators with infinite bus bars – synchronizing power torque – parallel operation and load sharing - Effect of change of excitation and mechanical power input. Analysis of short circuit current wave form – determination of sub-transient, transient and steady state reactances.

UNIT – IV Synchronous Motors:

Theory of operation – phasor diagram – Variation of current and power factor with excitation – synchronous condenser – Mathematical analysis for power developed. Power Circles: Excitation and power circles – hunting and its suppression – Methods of starting – synchronous induction motor.

UNIT – V Single Phase Motors & Special Machines:

Single phase Motors: Single phase induction motor – Constructional features-Double revolving field theory Equivalent circuit - split-phase motors - Capacitor start Capacitor run motors. Principles of A.C. Series motor-Universal motor, Stepper motor shaded pole motor, (Qualitative Treatment only).

TEXT BOOKS:

1. Electrical Machines – by P.S. Bimbra, Khanna Publishers.

2. Principles of Electrical Machines, V. K. Mehta, Rohit Mehta, S. Chand Publishing.
3. Electromachanics - III (Synchronous and single phase machines), S. Kamakashiah, Right Publishers.
4. Electric Machines, I. J. Nagrath & D. P. Kothari, Tata Mc Graw Hill Publishers.
5. Performance and Design of AC Machines, MG. Say, BPB Publishers.
6. Theory of Alternating Current Machinery, Langsdorf, Tata McGraw-Hill Companies.
7. Electric machinery, A.E. Fitzerald, C. Kingsley and S. Umans, Mc Graw Hill Companies.
8. Electric Machines, Mulukutla S. Sarma, Mukesh K. Pathak, Cengage Learning.
9. Fundamentals of Electric Machines, B. R. Gupta, Vandana Singhal, New Age International Publishers.
10. Electrical Machines, M. V. Deshpande, PHI Learning Private Limited.
11. Electrical Machines, R. K. Srivastava, Cengage Learning.

SEMESTER VI

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
ENG 321	Multi-Disciplinary Design Project	ELECTIVE	0	0	6	3

SEMESTER VI

Course Code	Course Name	Core/ Elective	Credit hr	L/T/P
ENV101	**INTRODUCTION TO ENVIRONMENTAL SCIENCE**			

UNIT I: Environment

Structure and functions in an ecosystem; Ecological succession; Ecological pyramids; Biosphere; Ecological systems and cycles – carbon cycle, water cycle, phosphorous cycle, nitrogen cycle, oxygen cycle; Broad nature of chemical composition of plants and animals; Natural resources covering renewable and non-renewable resources, forests, water, minerals, food and land; Energy sources, growing energy demands;

UNIT II: Environmental Pollution

Structure and composition of atmosphere. Pollution – air, water, soil, thermal and radiation. Effects – acid rain, ozone layer depletion and greenhouse gas emission. Control measures. Determination of water and air quality – BOD, COD, TDS, AQI.

UNIT III: Environmental Biotechnology

Environmental microbiology; Biomarkers; Biosensors; Biofuels; Biotransformation; Bioremediation, factors affecting bioremediation; Molecular Ecology

UNIT IV: Biodiversity and its conservation

Biodiversity hotspots; Values of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values; threats to biodiversity – habitat loss, poaching of wildlife; *in-situ* and *ex-situ* conservation.

UNIT V: Environmental protection and sustainability

Problems related to urban living, waste management, climate change, sustainable solutions, environmental regulation, and environmental protection acts in India and environmental ethic

Textbook required:

1) Basu. M, Xavier. S. "Fundamentals of Environmental Studies", 1st edition, Cambridge University Press, 2016.
2) Raina. M. Maier, Ian L. Pepper, Charles. P. "*Environmental Microbiology*" 2nd edition, Academic Press, 2004.

Reference book:

1) Danial. D. C. "Environmental Science", 8th edition, Jones and Barlett Publishers, MA, 2010.

SEMESTER VII

Course Code	Course Name	Core/ Elective	Credit hr	L/T/P
EE 403	Power system –III	CORE	4	3-0-2

UNIT-I : Objectives of Power System Operation [6]

Power Systems in Restructured Environment; Distributed and Dispersed Generation; Environment Aspects of Electric Power Generation.

UNIT-II: Economic Operation of Energy Generation Systems [10]

Generation Cost Curves; Economic Operation of Thermal System; Plant Scheduling; Transmission Loss and Penalty Factor; Hydro-Thermal Scheduling; Concept of Reserves and Constraints; Unit Commitment.

UNIT-III: Automatic Generation Control [8]

Concept of AVR and ALFC Loops, Significance of Double Loop in ALFC; Exciter and VAR Control; Single Area Load Frequency Control; Two Area Load Frequency Control; Frequency Response.

UNIT-IV: Compensation in Power System [8]

Reactive Power Sensitivity and Voltage Control; Load Compensation with Capacitor Banks; Line Compensation with Reactors; Shunt and Series Compensation; Fixed Series Capacitors; Thyristor Controlled Series Capacitors, Introduction to SVC and STATCOM.

UNIT-V: Power System Transients [8]

Types of System Transients; Overvoltage in Transmission Lines; Propagation of Surges and Travelling Waves; Protection Against Lightning and Surges;

Text Books

1. Power System Engineering, Kothari & Nagrath, Mc Graw Hill

2. Power System Analysis, Granger and Stevension, Mc Graw Hill

3. Electric Power Genration operation and control, Wood and Woolenberg, Willey.

4. Power system stability and Control, P. Kundur , Mc Graw Hill

5. Modern power system analysis, Kothari & Nagrath, Mc.Graw Hill

6. Power system Analysis, Nagsarkar & Sukhija, Pearson

7. Power system analysis, operation and control, Chakrabarti and Halder, PHI

SEMESTER- VIII

Project Work

OTHER ELECTIVES

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
OE-IV	Power plane Engineering	ELECTIVE	3	0	0	3

Unit-1: Coal based thermal power plants

Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems

Unit –II: power plant combustion cycles

Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

Unit-IV: Nuclear power plant

Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal, cooled reactors, safety measures for nuclear power plants.

Unit-V; hydro power plant and renewable energy source

Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologiesincluding waste disposal options for coal and nuclear plants.

Text Books:

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.

2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.

3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

OTHER ELECTIVES

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
OE-IV	FPGA programming	ELECTIVE	3	0	0	3

Course Description:

Introduction to FPGA Architectures, FPGA design flow, partitioning, placement and routing algorithms. Technology mapping for FPGAs, case studies. The goal of the course is to introduce digital design techniques using field programmable gate arrays (FPGAs). We will discuss FPGA architecture, digital design flow using FPGAs, and other technologies associated with field programmable gate arrays. The course study will involve extensive lab projects to give students hands-on experience on designing digital systems on FPGA platforms.

Topics:

- Introduction to ASICs and FPGAs
- Fundamentals in digital IC design
- FPGA & CPLD Architectures
- FPGA Programming Technologies
- FPGA Logic Cell Structures
- FPGA Programmable Interconnect and I/O Ports
- FPGA Implementation of Combinational Circuits
- FPGA Sequential Circuits
- Timing Issues in FPGA Synchronous Circuits
- Introduction to Verilog HDL and FPGA Design flow with using Verilog HDL
- FPGA Arithmetic Circuits
- FPGAs in DSP Applications
- Design Case Study: Design of SDRAM Controller
- Design Case Study: Design of Halftone Pixel Converter
- Programming FPGAs in Electronic Systems
- Design issues in complex systems containing both FPGA and Microprocessors

Books:

1. Brown, S. D., Francis, R. J., Rose, J. and Vranesic, Z G. Field programmable Gate arrays. Kluwer, 1992.
2. Betz, V., Rose, J. and Marquardt, A. Architecture and CAD for Deep-submicron FPGAs. Kluwer, 1999.
3. Trimberger, S. M. FPGA Technology. Kluwer, 1992.
4. Oldfield, J. V. and Dorf, R. C. FPGAs: Reconfigurable logic for rapid prototyping and implementation of digital systems. John Wiley, 1995
5. Steve Kilts, “Advanced FPGA Design,” Wiley Inter -Science, ISBN 9780470054376:
6. P. Chu, “FPGA Prototyping by Verilog Examples,” Wiley, 2008
7. P. Chu, “FPGA Prototyping by VHDL Examples,” Wiley, 2008

OTHER ELECTIVES

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
OE-V	Microprocessors and microcontrollers	ELECTIVE	3	0	2	4

Unit-I: Architecture of Microprocessors (12 hours)

Microprocessor architecture: introduction to microprocessor and microcomputer architecture, pins and signals, register organization, timing & control module, 8085 instruction timing & Execution, instruction set and assembly language programming of 8085 –instuction set of 8085, memory & I/O addressing, assembly language programming using 8085 instruction set, use of stack & subroutines, data transfer techniques, 8085 interrupts

Unit-II: Interfacing & support chips with 8086 (10 hours)

Interfacing ROMs, RAMs along with the explanation of timing diagrams memories, Interfacing with peripheral ICs like 8255, 8254, 8279, 8259,2716,2764,6116&6264etc. Microprocessor based system development aids, programmable DMA controller 8257, programmable interrupt controller :8259, Applications: Delay calculation, square wave generation, interfacing of key boards, LEDs, LCDs, ADCs, and DACs etc.

Unit-III: advanced microprocessor(10 hours)

Basic features od advance microprocessors, intel 8086(16 bit processor):-8086 architecture, register organization, signal descripitions, physical memory organization, addressing modes,instuction formats, instrution set & simple assembly language programmes,8086 interrupts,simple application: delay calculation, square wave generation

Unit IV: Microcontroller(10 hours)

introdution for microcontrollers, microcontroller&microprocessor,Embedded verses external memory devices, CISC&RISC processors, Havard & von neuman Architectures, 8051 microcontroller. MCS-51 Architectures,registers,stack pointer & program counter. 8051 pin description, connections, parallel I/O parts, memory organization , 8051 addesing modes& instrutions,8051 assembly language programming tools, simple apllication: delay calculation, square wave generation, interfacing of LCDunit etc**.**

Text Books:

1. 0000 to 8085 Introduction to microprocessor for scientist & engineers by Ghosh & Sridhar, PHI.
2. Fundamentals of microprocessor and microcontroller by B. RAM, Dhanpat Rai Publications.
3. Advanced microprocessor and peripherals (architecture, programming and interfacing) by A.K.Roy & K.M.Bhurchandi, TMH Publication.
4. Microprocessor, theory and applications by A.V.Deshmukh, TMH Publication.

OTHER ELECTIVES

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE 303	Advanced control theory	CORE	3	0	0	3

UNIT – I: State space analysis and design

Introduction State Space Representation – Solution of state equation – State transition matrix, – Canonical forms – Controllable canonical form – Observable canonical form, Jordan Canonical Form. Introduction to state model-effect of state feedback, necessary and sufficient conditions for arbitrary pole placement design of state observer separation principle servo design state feedback with integral control State Space Representation – Solution of state equation – State transition matrix, –Canonical forms – Controllable canonical form – Observable canonical form, Jordan Canonical Form.

UNIT – II: phase plane analysis:

Features of linear and nonlinear systems, common physical non linearity methods of linearization concept of phase portraits, singular points, limit cycles, construction of phase portraits, phase plane analysis of linear and nonlinear systems isoclines method

UNIT – III: Describing function analysis:

Introduction to nonlinear systems, Types of nonlinearities, describing functions, Introduction to phase–plane analysis.

UNIT–IV: Stability analysis:

Stability in the sense of Lyapunov – Lyapunov's stability and Lypanov's instability theorems – Direct method of Lypanov for the linear and nonlinear continuous time autonomous systems.

UNIT–V: Calculus of variations

: Minimization of functional of single function – Constrained minimization – Minimum principle – Control variable inequality constraints – Control and state variable inequality constraints – Euler lagrangine equation.

UNIT –VI Optimal control

: Linear quadratic optimal regulator (LQR) problem formulation – Optimal regulator design by parameter adjustment (Lyapunov method) – Optimal regulator design by continuous time algebraic riccatti equation (CARE) – Optimal controller design using LQG framework.

Text Books

1. Modern Control Engineering – by K. Ogata, Prentice Hall of India, 3rd edition, 1998

Automatic Control Systems by B.C. Kuo, Prentice Hall Publication

2. Modern Control System Theory – by M. Gopal, New Age International Publishers, 2nd edition, 1996
3. Control Systems Engineering by I.J. Nagarath and M.Gopal, New Age International (P) Ltd.
4. Digital Control and State Variable Methods – by M. Gopal, Tata Mc Graw– Hill Companies, 1997.
5. Systems and Control by Stainslaw H. Zak , Oxford Press, 2003.
6. Optimal control theory: an Introduction by Donald E.Kirk by Dover publications.

OTHER ELECTIVES

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE 307	Special machines	ELECTIVE	3	0	0	3

UNIT I SYNCHRONOUS RELUCTANCE MOTORS EE6703 Special Electrical Machines Syllabus

Constructional features – Types – Axial and Radial flux motors – Operating principles – Variable Reluctance Motors – Voltage and Torque Equations – Phasor diagram – performance characteristics – Applications.

UNIT II STEPPER MOTORS EE6703 Special Electrical Machines Syllabus

Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi stack configurations – Torque equations – Modes of excitation – Characteristics – Drive circuits – Microprocessor control of stepper motors – Closed loop control-Concept of lead angle– Applications.

UNIT III SWITCHED RELUCTANCE MOTORS EE6703 Special Electrical Machines Syllabus

Constructional features – Rotary and Linear SRM – Principle of operation – Torque production – Steady state performance prediction- Analytical method -Power Converters and their controllers – Methods of Rotor position sensing – Sensor less operation – Characteristics and Closed loop control – Applications.

UNIT IV PERMANENT MAGNET BRUSHLESS D.C. MOTORS

Permanent Magnet materials – Minor hysteresis loop and recoil line-Magnetic Characteristics – Permeance coefficient -Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations –Commutation – Power Converter Circuits and their controllers – Motor characteristics and control– Applications.

UNIT V PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM) EE6703 Special Electrical Machines

Principle of operation – Ideal PMSM – EMF and Torque equations – Armature MMF – Synchronous Reactance – Sine wave motor with practical windings – Phasor diagram – Torque/speed characteristics – Power controllers – Converter Volt-ampere requirements– Applications.

TEXT BOOKS:

1. K.Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.
2. T.J.E.Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 1989.
3. T.Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984.
4. R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2001.
5. P.P. Aearnley, 'Stepping Motors – A Guide to Motor Theory and Practice', Peter Perengrinus London, 1982.
6. T. Kenjo and S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.
7. E.G. Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014.

OTHER ELECTIVES

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE 402	Electrical machines design	ELECTIVE	3	0	0	3

UNIT-I INTRODUCTION

Major considerations in Electrical Machine Design - Electrical Engineering Materials – Space factor – Choice of Specific Electrical and Magnetic loadings - Thermal considerations – Heat flow – Temperature rise and Insulating Materials - Rating of machines – Standard specifications.

UNIT-II DC MACHINES

Output Equations – Main Dimensions – Choice of Specific Electric and Magnetic Loading Magnetic Circuits Calculations - Carter's Coefficient - Net length of Iron –Real & Apparent flux densities – Selection of number of poles – Design of Armature – Design of commutator and brushes – performance prediction using design values.

UNIT-III TRANSFORMERS

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

UNIT-IV INDUCTION MOTORS

Output equation of Induction motor – Main dimensions – Choice of Average flux density – 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 – Operating characteristics- Losses and Efficiency.

UNIT-V SYNCHRONOUS MACHINES

Output equations – choice of Electrical and Magnetic Loading – 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 – Determination of full load field mmf – Design of field winding – Design of turbo alternators –Rotor design.

TEXT BOOKS:

1. Sawhney, A.K., 'A Course in Electrical Machine Design', Dhanpat Rai & Sons, New Delhi, 1984.

2. M.V.Deshpande “Design and Testing of Electrical Machine Design” Wheeler Publications, 2010.

REFERENCES:

1. A.Shanmuga Sundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint, 2007.

2. R.K.Agarwal “ Principles of Electrical Machine Design” Esskay Publications, Delhi, 2002.

3. Sen, S.K., 'Principles of Electrical Machine Designs with Computer Programmes', Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1987.

OTHER ELECTIVES

SUBJECT CODE	SUBJECT TITLE	CORE/ ELECTIVE	CREDITS			
			L	T	P	C
EE 402	Computer techniques in power system	ELECTIVE	3	0	0	3

Unit-I: General Introduction (2 hours)

Modern Power Systems Operation and Control, Different types of Power System Analysis.

Unit-II: AC Power Flow Analysis (10 hours)

Introduction, Modeling of Power System Components, Power Flow Equations, Formation of Ybus Matrix, Power Flow Solution Algorithms, Newton Raphson Load Flow Method, Fast Decoupled Load Flow Method And DC Load Flow Method, AC-DC System Power Flow Analysis- Sequential and Simultaneous Solution Algorithms .

Unit-III Sparse Matrices (3 hours)

Sparsity directed Optimal Ordering Schemes, Solution Algorithms – LU Factorization, Factorization and Iterative Methods.

Unit-IV: Analysis of Faulted Power System (08 hours)

Symmetrical and Asymmetrical Faults, Zbus Formulation, Short Circuit Analysis of Large Power Systems using Zbus Analysis of Open Circuit faults.

Unit-V: Security Analysis (6 hours)

Basic Concepts, Static Security Analysis at Control Centers, Contingency Analysis, Contingency

Selection.

Unit -VI Stability Analysis (10 hours)

Classification of Power System Stability, Classical Model of Synchronous Machines and Excitation System, Transient Stability Analysis of Multi-Machine Systems, Eigen Analysis of Dynamical Systems, Small Signal Stability Analysis using Classical Model, Basic Concepts of Voltage Stability Analysis.

Reference Books:

1. O.I.Elgerd,Electric Energy Systems Theory – An Introduction, McGraw-Hill, 1988.

2. A.R.Bergen and Vijay Vittal,Power Systems Analysis, Pearson Education Asia, 2001.

3. J.J. Grainger and W.D.Stevenson,Power System Analysis, Mc Graw-Hill, New York, 1994.

4. I.J. Nagrath and D.P.Kothari,Power System Engineering, Tata Mc Graw Hill Publishing Co., 1994.

5. J.D. Glover, M.Sarma and T.J. Overbye,Power System Analysis and Design, Fourth Edition, Thomson Engineering Press, 2008.

6. P.Kundur,Power System Stability and Control, Mc GrawHill, 1994.

7. A.J. Wood and B.F. Wollenberg,Power Generation Operation and Control, John Wiley & Sons, 1996.

8. C.W. Taylor,Power System Voltage Stability, Mc Graw Hill, 1994.

9. L.Phillipson and H.L.Willis, Understanding Electric Utilities and Deregulation, Marcel Dekker Inc. 1998. 10. J Arrillaga,“High Voltage Direct Current Transmission”,Peter Peregrinus Ltd, UK