Bharati Vidyapeeth University, Pune

Faculty of Engineering & Technology

Programme : B.Tech (Electrical) Sem – III (2014 Course)

Sr. No.	Name of Course	Teaching Scheme			Examination Scheme							Credits		
		L	P	T	ESE	Continuous Assessment			Practical		Total	Theory	TW	Total
						Unit Test	Attendance	Assignment	TW PR	TW OR				
15	Engineering Mathematics –III	3	--	1	60	20	10	10	--	--	100	4	--	4
16	Electrical Machines – I	4	2	--	60	20	10	10	50	--	150	4	1	5
17	Linear & Digital Integrated Circuits	3	2	--	60	20	10	10	--	50	150	3	1	4
18	Digital Computational Techniques	3	2	--	60	20	10	10	--	50	150	3	1	4
19	Electrical Measurements & Instrumentation	3	2	--	60	20	10	10	50	--	150	3	1	4
20	Professional skill development - 3	4	--	--	100	--	--	--	--	--	100	4	--	4
	Total	**21**	**8**	**1**	**400**	**100**	**50**	**50**	**100**	**100**	**800**	**21**	**4**	**25**

Bharati Vidyapeeth University, Pune

Faculty of Engineering & Technology

Programme : B.Tech (Electrical) Sem – IV (2014 Course)

Sr. No.	Name of Course	Teaching Scheme			Examination Scheme							Credits		
		L	P	T	ESE	Continuous Assessment			Practical		Total	Theory	TW	Total
						Unit Test	Attendance	Assignment	TW PR	TW OR				
21	Power Electronics	3	2	--	60	20	10	10	--	50	150	3	1	4
22	Electrical Machines - II	4	2	--	60	20	10	10	50	--	150	4	1	5
23	Network Analysis	3	2	1	60	20	10	10	50	--	150	4	1	5
24	Generation, Transmission & Distribution	3	2	--	60	20	10	10	--	50	150	3	1	4
25	Electrical Engineering Materials	3	--	--	60	20	10	10	--	--	100	3	--	3
26	Professional skill development-4	4	--	--	100	--	--	--	--	--	50	4	--	4
	Total	21	8	1	400	100	50	50	100	100	800	21	4	**25**

Total Credits Sem – III : 25

Total Credits Sem – IV : 25

B.Tech (Electrical) – SEM-III

Engineering Mathematics-III		
TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 04 Hours / Week	End Semester Examination: 60 Marks	04 Credits
	Continuous Assessment: 40 Marks	

Course Pre-requisites:	
Students should have basic knowledge of:	
1.	Differential calculus
2.	Integral calculus
3.	Complex numbers
4.	Vector algebra

Course Objectives:	
	To develop ability to use the mathematical techniques, skills, and tools necessary for engineering practice.

Course Outcomes: At the end of the course , the students will be able to:	
1.	Form mathematical modeling of systems using differential equations and ability to solve linear differential equations with constant coefficient.
2.	Apply basics of analytic functions and the basics in complex integration which is used to evaluate complicated real integrals.
3.	Apply theorems to compute the Laplace transform, inverse Laplace transforms.
4	Solve difference equation by Z-transform.
5	Calculate the gradients and directional derivatives of functions of several variables.
6	Use Green's theorem to evaluate line integrals along simple closed contours on the plane.

UNIT - I	**Linear Differential Equations (LDE)**	**(09 Hours)**
	Solution of nth order LDE with Constant Coefficients, Method of Variation of Parameters, Cauchy's &Legendre's DE, Solution of Simultaneous & Symmetric Simultaneous DE, Modeling of Electrical Circuits.	
UNIT - II	**Complex Variables**	**(09 Hours)**
	Functions of Complex Variables, Analytic Functions, C-R Equations, Conformal Mapping, Bilinear Transformation, Cauchy's Theorem, Cauchy's Integral Formula, Laurent's Series, Residue Theorem	
UNIT - III	**Transforms**	**(09 hours)**
	Fourier Transform (FT): Complex Exponential Form of Fourier Series, Fourier Integral Theorem, Sine & Cosine Integrals, Fourier Transform, Fourier Sine and Cosine Transform and their Inverses. Introductory Z-Transform (ZT): Definition, Standard Properties, ZT of Standard Sequences and their Inverses. Solution of Simple Difference Equations.	
UNIT – IV	**Laplace Transform (LT)**	**(09 hours)**
	Definition of LT, Inverse LT. Properties & theorems. LT of standard functions. LT of some special functions viz., Periodic, Unit Step, Unit Impulse, ramp, jump, Problems on finding LT & inverse LT. Applications of LT and Inverse LT for solving ordinary differential equations.	
UNIT - V	**Vector Differential Calculus**	**(09 Hours)**

	Physical Interpretation of Vector Differentiation, Vector Differential Operator, Gradient, Divergence and Curl, Directional Derivative, Solenoidal, Irrotational and Conservative Fields, Scalar Potential, Vector Identities.	
UNIT - VI	**Vector Integral Calculus**	**(09 Hours)**
	Line, Surface and Volume integrals, Work-done, Green's Lemma, Gauss's Divergence Theorem, Stoke's Theorem, Applications to Problems in Electro-Magnetic Fields.	

Term Work:

1. Linear Differential Equations
2. Complex Variables
3. Transforms
4. Laplace Transform
5. Vector Differential Calculus
6. Vector Integral Calculus

Text Books:

1. Advanced Engineering Mathematics by Peter V. O'Neil (Cengage Learning).
2. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Eastern Ltd.).

Reference Books:

1. Engineering Mathematics by B.V. Raman (Tata McGraw-Hill).
2. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
3. Advanced Engineering Mathematics, Wylie C.R. & Barrett L.C. (McGraw-Hill, Inc.)
4. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).
5. Applied Mathematics (Volumes I and II) by P. N. Wartikar & J. N. Wartikar (Pune Vidyarthi Griha Prakashan, Pune).

Syllabus for Unit Test:	
Unit Test -1	UNIT – I, UNIT – II, UNIT - III
Unit Test -2	UNIT – IV, UNIT – V, UNIT - VI

Electrical Machines - I		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 03 Hours / Week	End Semester Examination: 60 Marks	03 Credits
Practical: 02 Hours / Week	Continuous Assessment: 40 Marks	
	Term Work: 25 Marks Practical : 25 Marks	01 Credit

Course Pre-requisites:	
The Students should have knowledge of	
	Basic of Machine, Magnetic theory, AC & DC Fundamentals
Course Objectives:	
	To develop the students to identify, analyze & to understand the fundamentals, classification, application and selection of DC machine, Transformer & Induction Machines for a particular application as per the operational characteristics.
Course Outcomes: The students will be able to	
1.	To draw equivalent circuit, phasor diagram and calculate the efficiency and regulation of single phase transformer
2.	Identify the difference between the single phase and three transformers and also will Apply the concepts and application of the three phase transformer and also can analyze using the basics of additional terms & various connections of the three phase transformer.
3.	Apply the concepts and application of Electromagnetic Laws, Energy balance.
4.	Identify different parts, Describe the basics of machine, armature reaction, commutation, characteristics & applications of dc generators, dc motors
5.	Apply the concepts and application of single phase induction motors and other small size motors.
6.	Apply the concepts and application of advancements in DC machines & transformers.

UNIT – I	**Single Phase Transformers**	**(06 Hours)**
	Introduction to Single phase transformer, Development of equivalent circuit, Approximate & Exact equivalent circuit, & Phasor diagram, Efficiency of a Transformer, Condition for maximum efficiency, All day efficiency of Transformer, single phase Autotransformer, saving in copper. Kapp regulation diagram, Back to back test, Open circuit and Short circuit tests on single phase Transformer, Routine and Type Test on single phase transformer as per IS, Parallel operation of single phase Transformer.	
UNIT – II	**Polyphase Transformers**	**(06 Hours)**
	Comparison between single three phase unit and three single phase units, standard connections & phasor groups, parallel operation of three phase transformers, Three winding transformers, On-Load Tap Changer. Concept of polarity & Polarity Test, open circuit and short circuit tests, Direct Load Test, Sumpner's test (Back to back), I.S. Specifications of transformers. Concept of routine and type tests. Testing of transformers as per I.S. specifications.	
UNIT – III	**Principles of Electromechanical Energy Conversion**	**(06 Hours)**
	Introduction, Basic Electromagnetic Laws, EMF induced in a coil rotating in a magnetic field, forces and torques in magnetic field systems, Energy balance, Energy in singly excited magnetic field systems, Determination of magnetic force and torque from Energy, Multiply excited magnetic field systems, Forces and torques in systems with permanent magnets, Dynamic equations	
UNIT – IV	**DC Machines**	**(06 Hours)**

	Basic principle of working, Construction, E.M.F. equation of D.C. generators. Process of commutation & types, causes of bad commutation and remedies, Basic principle of working of DC motor, Significance of Back e.m.f., Torque equation, Types, characteristics and applications of d.c. motors, Starting, reversing and armature voltage and field control method of speed control, Armature reaction, Losses, efficiency, condition for maximum efficiency and maximum power output. Testing of DC motor.	
UNIT – V	**Fractional Kilowatt Motors**	**(06 Hours)**
	Construction of single phase induction motors, types, double revolving field theory, methods of self-starting, torque-speed/slip characteristics, equivalent circuit, applications, Shaded Pole motor, Commutator motors, Universal motor, Repulsion motors, Servo motors	
UNIT – VI	**Modern Trends in DC Machines and Transformers**	**(06 Hours)**
	Construction, working, characteristics and applications of: PMDC Motor, Stepper motor, BLDC motor, Printed Circuit Board Motor, Air Motor, dry type transformer, isolation transformer, Optical CT/PT	

Term Work:

The Practical's shall consist of record of minimum eight experiments.

1. Open circuit and short circuit tests on a single phase transformer
2. Performance of standard connections (Scott and open delta) for three phase transformers
3. Sumpner's test on two identical single phase transformers
4. Parallel operation of two single phase transformers
5. Three phase to six phase transformation
6. Identification of DC machine windings and resistances
7. Speed control of D. C. Shunt motor by Armature and Field control
8. Brake test on DC shunt motor
9. Swinburn's Test on DC shunt Motor
10. Load test on single phase induction motor (Split phase induction motor)
11. Computation of Equivalent Circuit of single phase induction motor
12. Load test on ac series motor

Text Books:

1. Nagrath Kothari, "Electrical Machines", Tata McGraw Hill
2. A. E. Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans, "Electric Machinery", Tata McGraw Hill
3. M. G. Say, "Alternating Current Machines", Pitman Publishing Ltd.
4. Ashfaq Husain, "Electric Machines", Dhanat Rai & Co.

Reference Books:

1. Dr. S. K. Sen, "Electric Machinery", Wiley Eastern
2. B. H. Deshmukh, "Electrical Technology", Nirali Prakashan
3. A. S. Langsdroff, "Theory of Alternator Current Machinery", Tata McGraw Hill
4. Bhag S. Guru, Huseyin R. Hiziroglu, "Electric Machinery & Transformers", Oxford.

Syllabus for Unit Test:	
Unit Test -1	UNIT – I, UNIT – II, UNIT - III
Unit Test -2	UNIT – IV, UNIT – V, UNIT - VI

Linear and Digital Integrated Circuits		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 03 Hours / Week	End Semester Examination: 60 Marks	03 Credits
Practical: 02 Hours / Week	Continuous Assessment: 40 Marks	
	Term Work: 25 Marks Oral 25marks	01 Credit

Course Prerequisites:	
The students should have knowledge of	
1.	Fundamentals of semiconductor physics, electronics devices
Course Objectives:	
	This course introduces basic knowledge about linear and Digital integrated circuits. It describes fundamentals of Operational amplifier characteristics and application circuits. It also introduces concepts of digital components, combinational and sequential circuits.
Course Outcomes: After learning this course the students will be able to	
1.	Specify operational amplifier parameters and connect the operational amplifier to perform basic applications.
2.	Describe the operation of circuit with proper component ratings, circuit diagram, input, output waveforms.
3.	Compare specifications of voltage regulator ICs and select as per requirements. Identify pins of IC 555 and analyze circuits of IC 555
4	Apply knowledge of number conversion and binary arithmetic and to use Boolean algebra to develop K map logic.
5	Draw logic circuits of multiplexer , de-multiplexer, ADC, DAC
6	Describe different flip- flops with circuit diagram, truth table and applications such as registers, counters

UNIT - I	**Operational Amplifiers**	**(06Hours)**
	Block diagram and working of operational amplifier, pin diagram and specifications of IC 741,IC 324, operational amplifier parameters input offset current, input offset voltage, Common Mode Rejection Ratio (CMRR), PSRR, slew rate, bandwidth and frequency response, Basic op-amp applications: Inverting amplifier, Non-inverting amplifier, Adder, Subtractor, Instrumentation amplifier, AC voltage follower, V to I and I to V converter	
UNIT - II	**Waveform Generators using Operational Amplifiers**	**(06 Hours)**
	Integrator, differentiator, Square, triangular, sine wave generator, saw-tooth, Comparator, zero crossing detector, Schmitt trigger, precision rectifier, peak detector, clipper, clamper,V to F and F to V converter, sample and hold circuit	
UNIT - III	**Applications of Op-Amp and Other IC's**	**(06Hours)**
	Voltage regulators using ICs Viz. 78xx, 79xx, LM 317, IC 723 Active filters - configuration with frequency response, Analysis of first order low pass and high pass filters, Timer IC555 construction, working and modes of operation: astable, monostable and sequence timer	
UNIT - IV	**Numbering Systems and Boolean Algebra**	**(06 hours)**
	Numbering systems - binary, octal, decimal and hexadecimal and their conversion, codes - BCD, ASCII, Grey and excess3, Binary arithmetic: addition and subtraction by 1's and 2's compliment. Logic gates, Booleans algebra, De-Morgon's theorem, K-map: structure for two and three variables, SOP and POS form reduction of Boolean expressions by K-	

	map 1-bit comparator analysis using K-map	
UNIT - V	**Combinational Logic Circuits**	**(06Hours)**
	Comparator, parity generator, Multiplexer, De-multiplexer using K-map, adder, subtractor, arithmetic logic unit , decimal to BCD encoder (74147), BCD to 7 segment decoder/driver (7446/7447), display device, ADC, Dual slope SAR, DAC - binary weighted, ladder type, Memories: RAM - static and dynamic, ROM, PROMS and EPROMS, EEPROMS detailing.	
UNIT - VI	**Sequential Logic Circuits**	**(06 Hours)**
	Flip Flops: S-R, Clocked S-R, D latches, Edge triggered D flip-flops, Edge triggered JK flip flops, JK Master-slave flip flop, Registers, Buffer registers, shift registers, controlled shift registers, asynchronous counters, synchronous counter, twisted ring counters, N-module counters, Counter IC's	

Term Work:

The term work shall consist of record of minimum eight experiments. Four from first 6 and four from next 6 out of given below.

1. To Study Data sheet of IC 741, 324 , IC555, IC 723
2. To observe op. amp as adder, subtractor
3. To observe operational amplifier as square, triangular wave, sine wave generator.
4. To observe operation of operational amplifier as comparator, ZCD, Schmitt trigger
5. To observe input, output waveforms of an Operational amplifier as integrator and differentiator.
6. Operational amplifier as low pass or high pass filter and observe frequency response
7. To connect IC 555 as mono-stable multi vibrator and observe waveforms.
8. To connect logic gates as per pin diagram and verify truth table
9. To design half adder and full adder using basic gates.
10. To verify operation of various flip flops by truth table
11. To observe shift register operation using IC7495
12. To understand features of synchronous and asynchronous counter and use them for different modes such as up/down, mode N, frequency divider.
13. To use BCD to 7 segment decoder (7446,7447) BCD to decimal decoder (7441, 7442)
14. To study specifications of ADC and DAC chips

Text Books:

1. D. Roy Choudhary , Shail Jain – "Linear Integrated Circuits" -Wiley Eastern Limited.
2. R. P. Jain - "Modern Digital Electronics"–Tata McGraw hill
3. K. R. Botkar –"Integrated circuits"- Khanna publishers

Reference Books:

1. Ramakant A. Gaikwad- "Op-amp and Integrated circuits", Fourth edition, PHI Publication, 2002.
2. L. K. Maheshwari and M.M. S Anand – "Analog Electronics" -Prentice Hall of India, New Delhi
3. D. P. Leach, A. P. Malvino- "Digital principles and applications" -Tata McGraw Hill
4. James - "Operational amplifier and linear Integrated Circuits Theory and applications"
5. Charles H. Roth –"Fundamental of Logic Design" –Jaico book

Syllabus for Unit Test:	
Unit Test -1	UNIT – I, UNIT – II, UNIT - III
Unit Test -2	UNIT – IV, UNIT – V, UNIT - VI

Digital Computational Techniques		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 03 Hours / Week	End Semester Examination: 60 Marks	03 Credits
Practical: 02 Hours / Week	Continuous Assessment: 40 Marks	
	Term Work: 25 Marks Practical : 25 Marks	01 Credit

Course Pre-requisites:	
The Students should have knowledge of	
1.	Mathematics (integration, differentiation, simultaneous equations, polynomial equations), Basics of programming, C++ language, Program debugging skills, Flowchart and algorithm development
Course Objectives:	
	To develop the students for understanding, analyzing and applying numerical methods using digital techniques (C++ and MATLAB) to solve mathematical and engineering problems.
Course Outcomes: The students will be able to	
1.	Refresh the basics of C++ language and MATLAB and solve problems using multiple numerical techniques with C++ and MATLAB
2.	Understand importance of high speed calculations, errors involved and preliminary mathematical theorems
3.	Find the roots of transcendental & polynomial equations
4.	Understand and use various numerical interpolation methods to solve polynomial equations
5.	Perform numerical differentiation and integration using multiple methods/techniques
6.	Solve linear algebraic simultaneous equations using elimination and iterative methods

UNIT – I	**Basics of C++ and MATLAB Programming**	**(06 Hours)**
	Data types, Operator, Variables, Control Statements, Loops, Access Control, Arrays, Functions and their types, Object Oriented Programming (OOPS) concepts, Class and Object, Abstraction, Encapsulation, Inheritance, Polymorphism, Parameter passing, Function overloading, Inline functions, Virtual functions, Friend functions, Members and Functions, MATLAB Basics (operations, built-in functions, commands, arrays, display, files, programming in MATLAB	
UNIT – II	**Introduction to Numerical Computations:**	**(06 Hours)**
	Basic principle of numerical methods and necessity of computers for high speed calculations, Floating point algebra with normalized floating point technique, Significant digits, Mathematical preliminaries: Rolle's Theorem, Generalized Rolle's Theorem, Intermediate Value Theorem, Mean Value Theorem for derivatives, Errors and their computations: Absolute, Relative and Percentage errors	
UNIT – III	**Transcendental and Polynomial Equations:**	**(06 Hours)**
	Roots of an equation and methods to find the same, Solve equations using Bisection, Secant, Regula-Falsi and Newton-Raphson methods, Single variable and multi variable Newton-Raphson techniques, Curve fitting using least square approximation – first order and second order.	
UNIT – IV	**Interpolation:**	**(06 Hours)**
	Introduction to interpolation and calculas of finite differences, Polynomial interpolation methods: Lagranges, Newton's forward, backward & central difference methods, Sterling and Bessel's interpolation	
UNIT – V	**Differentiation and Integration:**	**(06 Hours)**
	Numerical differentiation using simple interpolation techniques like Lagrangian and Newton Gregory methods, Numerical integration using Trapezoidal, Simpsons	

	Rule, Solution of ordinary differential equation using Euler's, Modified Euler's, Taylor Series, Runge-Kutta second and fourth order techniques using Hune's and Polygon method	
UNIT – VI	**Linear Algebric Simultaneous Equations:**	**(06 Hours)**
	Direct methods like Gauss Elimination method and Gauss Jordan method, Concept of pivoting – partial and complete, Iterative methods like Gauss-Siedel, Accelerated Gauss-Siedel and Jacobi's method, Matrix inversion using Jordan method and Eigen Values using Power method and Jacobi methods	

Term Work:

The Practical's shall consist of record of minimum eight experiments.

13. Newton-Rhapson method using C++ Programming
14. Gauss Elimination method using C++ Programming/MATLAB
15. Gauss Seidel Method using MATLAB
16. Jacobi Method using MATLAB
17. Lagranges Interpolation method using C++ Programming
18. Newtons Divided Difference Interpolation method using C++ Programming
19. Trapezoidal method using C++ Programming
20. Euler's method using C++ Programming
21. Runge-Kutta 4th Order method using C++ Programming
22. C++ Program on Inheritance
23. C++ Program on Polymorphism
24. C++ Program on derived class constructor and destructor

Text Books:

3. S. S. Sastry, "Introductory Methods of Numerical Analysis", 4th Edition, PHI
4. M. K. Jain, R. K. Jain, S.R.K. Iyengar, "Numerical Methods for Scientific and Engineering Computation", 6th Edition, New Age International Publishers
5. Balaguruswamy, "Object Oriented Programming in C++", Edition 2008, Tata McGraw Hill
4. Yashavant Kanitkar, "Let Us C++",2nd Edition, BPB Publications
5. Dr. J. S. Chitodia, "Numerical Methods", Technical Publications
6. Rao V. Dukkipati, "MATLAB – An Introduction with Applications", New Age International Publishers

Reference Books:

5. Santosh K. Gupta, "Numerical Methods for Engineers", Wiley Eastern Ltd.
6. John R. Hubbard, "Schaum's Outline of Programming with C++", 2nd Edition, Schaum's Series
7. Babu Ram, "Numerical Methods", Pearson Publications

Syllabus for Unit Test:	
Unit Test -1	UNIT – I, UNIT – II, UNIT - III
Unit Test -2	UNIT – IV, UNIT – V, UNIT - VI

Electrical Measurement and Instrumentation		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 03	End Semester Examination: 60 Marks	03 Credits
Practical: 02	Continuous Assessment: 40 Marks	
	Practical:	01 Credit

Course Pre-requisites:	
The Students should have knowledge of	
1.	Basic electrical Engineering Parameters such as Voltage, current, Power, Energy, etc.
2.	Various physical Parameters such as, Temperature, Pressure ,Flow, vibration, etc.
Course Objectives:	
	This course introduces knowledge about electrical measurement and instrumentation .The course is designed to learn different methods of measurements of various electrical parameters and also to learn the different physical parameters with the help of the various measurement and instrumentation techniques.
Course Outcomes:	**After learning this course students will be able to**
1.	Explores the importance of measurement and various terms related to measurement. Measure /calculate unknown inductance and capacitance by balancing of AC bridge State specifications of instrument transformers and use them for high voltage and high current measurement.
2.	Draw circuit diagram, connect wattmeter for measurement of three phase active and reactive power and energy meter for measurement of energy.
3.	Draw block diagram , state specifications, functions of various digital/automated meter, harmonic analyzer
4	Classify various types of transducers. Explain principle of operation, characteristics, specifications of displacement and level transducers and different methods of measurement.
5	Explain principle of operation, characteristics, specifications of Pressure and temperature transducers and different methods of measurement.
6	Select appropriate transducer , recorder and display device as per requirement

UNIT – I	**Introduction**	**(06 Hours)**
	Introduction: significance of measurement, classification of instruments, mechanical, electrical, electronic instruments, deflection and null type, applications of measurement system. **AC Bridges:** Introduction, sources and detectors for ac bridge, general equation for bridge at balance. Measurement of Inductance: Maxwell's Inductance & Maxwell's Inductance – Capacitance Bridge, Anderson's Bridge, Schering Bridge for measurement of capacitance, Wien's Bridge for measurement of frequency, Universal Impedance Bridge **Instrument Transformers:** Introduction to CT & PT as instrument transformers. Difference between CT operated meter & whole current meter. Advantages of instrument transformers over shunts and multipliers, Accuracy class, burden on instrument transformers, expression for ratio and phase angle errors in case of C.T. and P.T. (No derivation), and precaution in using instrument transformers. Clip on ammeter.	
UNIT - II	**Measurement of Power and Energy**	**(06 Hours)**
	Measurement of Power: Construction, working principle, torque equation, advantages/disadvantages, errors and their compensation of dynamometer type wattmeter, low power factor wattmeter, Active & reactive power measurement in three phase balanced & unbalanced system (one wattmeter and two wattmeter methods), Power Measurement using Instrument Transformer, Three Phase wattmeter.	

	Measurement of energy: Energy Meters in AC circuits, Single Phase Induction Type Energy Meter - Construction, principle of operation, torque equation of induction type energy meter, errors and adjustments. Three phase three wires, and three phase four wire energy meter, Electronic energy meter	
UNIT - III	**Electronic Devices and Signal Analyzer's**	**(06 Hours)**
	Electronic Voltmeters and their Advantages, Vacuum Tube Voltmeters, difference Amplifier Type Voltmeters, DC Voltmeters with direct Coupled Amplifier, Measurement of Power at Audio and Radio Frequencies. Digital Storage Oscilloscope – Principle of operation and waveform reconstruction. Concept of: Numeric meter & its types (TOD, ABT, Prepaid & panel mounted meters.) Measurement of power & energy by sampling technique automatic meter reading (AMR) and advanced metering infrastructure (AMI), Meter reading instrument (MRI). Wave Analyzers – Frequency Selective Wave Analyzers and Heterodyne Wave Analyzers and its applications. Harmonic Distortion Analyzer, Spectrum Analyzer, Standing Wave Ratio, Power Analyzer.	
UNIT - IV	**Displacement and Level Measurement**	**(06 Hours)**
	Introduction to Transducers, classification, basic requirements for transducers and Advantages of Electrical Transducers. **Displacement measurement:** Potentiometer as displacement transducer**,** Strain Gauge: Theory of Strain Gauges, Types of strain gauges: Un-bonded and Bonded types their construction, working, advantages and disadvantages, load cell, LVDT & RVDT – construction, working, application, null voltage, specifications, advantages/disadvantages, effect of frequency on performance. Capacitive transducers – Advantages, Disadvantages and Applications. **Level measurement:** Introduction and importance of level measurement, level measurement methods: mechanical, hydraulic, pneumatic, Electrical types of level gauges using resistance, capacitance, nuclear radiation and ultrasonic sensors	
UNIT - V	**Pressure and Temperature Measurement**	**(06 Hours)**
	Pressure Measurement:, classification of pressure as low/medium/ high, absolute/gauge/vacuum, static/dynamic & head pressure. Types of Pressure Measurements Devices, Pressure Measurement using Electrical Transducers as Secondary Transducers. Low Pressure Measurement – Thermocouple Vacuum Gauge, Pirani Gauges and Ionization Type Vacuum. Temperature Measurement: Electrical Resistance Thermometer, Platinum Resistance Thermometer, Semi conductor Thermometers, Thermocouples, Thermisters, Quartz Crystal Thermometers, Bimetallic Thermometers. Electrical methods of temperature measurement – signal conditioning of industrial RTDs and their characteristics – 3 lead and 4 lead RTDs.	
UNIT - VI	**Measurement of Velocity and Flow, Recorders and Display Devices**	**(06 Hours)**
	Measurement of Velocity – Moving Magnet Type, Moving Coil Type, Seismic Tape Type. Measurement of Angular Velocity. **Measurement of flow –** Turbine Meter, Electromagnetic Flow Meters, Hot Wire Anemometer, Ultrasonic Flow Meter. **Recorders and Display Devices:** Recording Requirement, Analog Recorders, Graphic Recorders, Strip Chart Recorders, Null Type Recorders, X-Y Recorders, Ultraviolet Recorders, Direct Recorders. Digital Display Methods, Digital display Units, Rear Projector Display, Light Emitting Diodes (LED), Liquid Crystal Diodes (LCD), Resolution and Sensitivity of Digital Meters	

<u>Term Work:</u>

The term work shall consist of record of minimum eight experiments.

1. Calibration of ammeter and voltmeter with the help of potentiometer.
2. To extend range of wattmeter by use of CT and PT.
3. To measure power in three phase balanced load by one wattmeter method.
4. To measure power in three phase balanced/ unbalanced load by two wattmeter method.
5. To measure reactive power in three phase circuit by one wattmeter method.

6. To study and analyze the various electrical parameters using Power Analyzer.
7. To calibrate single phase energy meter at (i) unity power factor (ii) 0.5 lagging power factor (iii) 0.5 leading power factor (analog / Digital)
8. Study of digital storage oscilloscope C.R.O.s of different types and their applications.
9. Measurement of capacitance and loss angle by Schering Bridge.
10. Measurement of inductance by Anderson's bridge.
11. Displacement measurement by LVDT.
12. Strain measurement using strain gauge.
13. Bourdon Tube
14. Study of process control application of using the instrumentation kit.
15. Introduction to thermography, detection of hot spots, oil level, defective winding in transformer using thermo vision techniques.

Text Books:

1. A Course in Electrical and Electronic measurements & Instrumentation – by A. K. Sawhney, Dhanpat Rai & Sons.
2. Electronic Instrumentation: H.S. Kalsi – THM, 2nd Edition 2004.
3. A Course in Electronic and Electronic measurements by J. B. Gupta, S. K. Kataria & Sons.
4. Measurement by Baldwin

Reference Books:

1. Electrical Measurement & Measuring Instruments Fifth edition, by E. W. Golding & Widdies, A. H. Wheeler & Co. Ltd.
2. Electronic measurement and instrumentation by Dr. Rajendra Prasad, Khanna Publisher, New Delhi.
3. Introduction to Measurements and Instrumentation, Second Edition by Ghosh, PHI Publication.
4. Introduction to Measurements and Instrumentation by Anand .PHI Publication

Syllabus for Unit Test:	
Unit Test -1	UNIT – I, UNIT – II, UNIT - III
Unit Test -2	UNIT – IV, UNIT – V, UNIT - VI

B.Tech (Electrical) - SEM–IV

Power Electronics		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 03 Hours / Week	End Semester Examination: 60 Marks	03 Credits
Practical: 02 Hours / Week	Continuous Assessment: 40 Marks	
	Term Work: 25 Marks Oral 25 marks	01 Credit

Course Pre-requisites:

The Students should have knowledge of

1.	Fundamentals of Electronics Engineering.

Course Objectives:

This course introduces basic knowledge about electronics devices used for control of power. It describes characteristics, application circuits of SCR and other power devices.

Course Outcomes: After learning this course the students will be able to

1.	Describe specifications, characteristics of power electronics components.
2.	Explain operation of AC-AC converters at different load conditions with mathematical equation and waveforms
3.	Explain operation of AC-DC converters at different load conditions with mathematical equation and waveforms
4	Compare and select among switching device (IGBT, MOSFET, MCT) as per the application requirement.
5.	Compare and select various Choppers based on application requirements.
6.	Compare Voltage Source Inverter (VSI) and Current Source Inverter (CSI)

UNIT - I	**Thyristor Power Devices**	**(06 Hours)**
	SCR - static and dynamic characteristics, specifications, two transistor analogy, gate characteristics, triggering circuits, protection of SCR Protection of power circuit from - over voltage, over current & temperature rise (thermal) Design of Snubber circuit.	
UNIT - II	**AC to DC Convertors (Single phase and three phase)**	**(06 Hours)**
	Single phase convertor, three phase semi controlled and fully controlled bridges with R, RL and RLE loads, derivation of average and RMS output voltage and current, rectification and inversion mode of operation, concept of overlap angle and associated voltage drop calculation, dual convertor and selection of transformer and semiconductor devices for convertors. Total Harmonic Distortion (THD).	
UNIT - III	**AC Voltage Controllers**	**(06 Hours)**
	DIAC, TRIAC - construction, characteristics, four mode operation, specifications, triggering of TRIAC using DIAC, AC voltage regulator principle, single phase and three phase analysis with R and RL Load, Harmonics and ripple factor, Applications of two stage, three stage and multistage voltage controllers, derivation of average and RMS output voltage and current	
UNIT - IV	**Transistor Power Devices**	**(06 Hours)**
	MOSFET, IGBT, MCT - Construction, Characteristics, Specifications, Safe Operating Areas, protection, switching action and their control circuit requirement, comparison and area of application of these devices, Diagram and working of Switched Mode Power supply (SMPS) and Uninterrupted Power Supply (UPS)	
UNIT - V	**DC to DC Convertors**	**(06 Hours)**
	Principle of operation of chopper, classification on the basis of operating quadrants control techniques, CLC, TRC, PWM and FM techniques, analysis of step up choppers and numerical with RLE load, area of application, necessity of input filter, derivation of average and RMS output voltage and current	
UNIT - VI	**DC to AC Inverters**	**(06 Hours)**
	Single phase and three phase inverters principle of operation, VSI and CSI inverters, applications, operating frequency range. PWM inverters: single pulse, multi-pulse and sinusoidal pulse modulation, PWM techniques for voltage control and harmonic elimination.	

Term Work:
The term work shall consist of record of minimum eight experiments. Four from first 6 and four from next 6 out of given below.
1. V-I Characteristic of SCR, DIAC & TRIAC
2. V-I characteristic of power semiconductor devices GTO, MOSFET, IGBT
3. 1 Phase half Controlled & Full controlled converter (R & RL Load)
4. 3 phase converter (R, RL, RLE Load)
5. Step down Chopper circuit (RC technique)
6. 3 phase Voltage Source transistorized inverter
7. Firing circuit for 3 phase converter
8. 1 phase or 3 phase AC voltage regulator
9. 3 phase AC – DC converter with RLE Load
10. 1 phase PWM bridge inverter
11. Commutation circuit of SCR
12. Design of Snubber Circuit
13. Collection of data sheets of Power Devices
14. Summary reports of NPTEL videos on Power Devices
Text Books:
1. M. H. Rashid – "Power Electronics" 2009 Edition, Pearson publication
2. Ned Mohan, Undeland, WP Robins - "Power Electronics" 3rd edition, John Wiley & Sons International Student edition
3. B. W. Williams – "Power Electronics" 2nd edition -Macmillan publication
4. Dr. P. S. Bhimbra - "Power Electronics" third edition, Khanna Publication
5. K Hari Bapu - " Power Electronics" - Scitech Publication
Reference Books:
1. Vedam SubraManyam - "Power Electronics" - New Age international, New Delhi
2. Dubey, Donald, Joshi, Sinha - "Thyristerised Power Controller"- Wiley Eastern New Delhi
3. M. D Singh & K B Khandchandani, "Power Electronics" - Tata McGraw hill
4. Jai P Agarwal - "Power Electronics, Systems theory & design" LPE Pearson Education
5. L Umanand - "Power Electronic, Essentials & Applications" - Wiley publication
6. Randall , Shaffer - "Fundamental of Power Electronics with Matlab"
7. J. Michale, Jacob - "Power Electronics Principles & Applications"
8. V K Mehta – "Principles of Electronics" – S. Chand Publications
9. NPTEL website Video lectures by B. G. Fernandes

Syllabus for Unit Test:	
Unit Test -1	UNIT – I, UNIT – II, UNIT - III
Unit Test -2	UNIT – IV, UNIT – V, UNIT - VI

Electrical Machines-II			
TEACHING SCHEME:		**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 04 Hours / Week		End Semester Examination: 60 Marks	04 Credits
Practical: 02 Hours / Week		Continuous Assessment: 40 Marks	
		Term Work: 25 Marks	01 Credit
Course Pre-requisites:			
The Students should have knowledge of			
1.	Basic laws of rotating machines like Faraday's Law, Lenze's Law, etc		
2.	Basics of Electrostatics and electromagnetic		
3.	Transformer operation		
4.	Induction machine operation		
5.	DC Machine operation		
Course Objectives:			
	To understand the theory, operation, characteristics and applications of Three phase Induction, Synchronous Machines and special purpose machines.		
Course Outcomes: The students will be able to			
1.	Describe the basics of synchronous generators & identify the different parts, different excitation systems, armature windings, to find the regulation by different methods of non-salient pole alternator.		
2.	Apply the concepts of three phase synchronous generator and analyze using the basics of different tests on Syn. Gen.		
3.	characteristics of alternators		
4	Understand the concept of synchronization and parallel operation of alternators		
5	Understand working principle, characteristics, operation and applications of synchronous motors		
6	Understand working, characteristics and usage of special purpose electrical machines		
UNIT - I	**Synchronous Generators (Alternators) - Principles**		**(08 Hours)**
	Types of synchronous machines & their constructional features, Excitation Systems. **Synchronous generator (cylindrical rotor type**): Principle of working, Armature Windings & Estimation of winding factor, EMF Equation, Rating of Generator, Generator on no load & balanced load, Armature reaction & its effect under load power factors, Synchronous Impedance, Equivalent Circuit & Phasor Diagram, **Synchronous Generator (Salient Pole**): Two Reaction Theory model, Estimation of Direct & Quadrature axes Synchronous Reactance by Slip Test, Phasor Diagram. Power Flow (Transfer) Equations, Power – Power angle relation and Capability Curves of synchronous generators.		
UNIT - II	**Synchronous Generators (Alternators) - Operation**		**(08 Hours)**
	DC resistance test, Open circuit Test & Short Circuit Test on synchronous generator, Determination of Voltage Regulation by direct load test & by Indirect Methods-EMF, MMF & Potier Triangle Method, Losses & Efficiency and Short Circuit Ratio. Parallel Operation of alternators - Necessity, Conditions, Prime Mover Characteristics & load Sharing. Concept of Infinite bus, alternators connected to infinite bus bar, Methods of		

	synchronizing alternators (synchronizing lamps and synchro-scope), Significance of Synchronizing Power Coefficient.	
UNIT - III	**Three Phase Synchronous Motor**	**(08 Hours)**
	Principle of operation, Methods of starting, Equivalent Circuit & Phasor Diagrams, Pull-in & Pull-Out Torque, Power Flow Equations, Operation with constant excitation & variable load and with Constant load & variable excitation (V Curves & Inverted V Curves), Phenomenon of Hunting & its remedies, Applications.	
UNIT - IV	**Three Phase Induction Motor – Principles**	**(08 Hours)**
	Construction (Squirrel cage, Wound rotor), Concept of rotating magnetic field, Principle of Operation, Concepts of Speed & Slip, Frequency of rotor voltage & current, Power Flow Diagram & development of Equivalent Circuits, Losses, Relationship between rotor copper loss , rotor input & gross mechanical power developed,Efficiency,Torque–Slip/Speed characteristics, Effect of rotor resistance on Torque-Slip characteristics, Condition for maximum torque, Relations between starting ,Full load & Maximum torque.	
UNIT - V	**Three Phase Induction Motor – Operation**	**(08 Hours)**
	Starters for cage rotor & wound rotor induction motors (DOL, Star/Delta, Auto transformer, Stator resistance, Rotor resistance, soft starters), Open circuit and short circuit test, Circle diagram and computation of performance parameters, High Torque Cage Motors - Deep bar & Double cage rotor, Speed control mechanisms (VFD, cascading, pole changing, slip power recovery), Cogging & Crawling of induction motors, Applications.	
UNIT - VI	**Special Purpose Machines**	**(08 Hours)**
	Construction, working principle, characteristics and applications – Induction Generator, Induction Voltage Regulator, Linear Induction Motor, Synchronous Induction Motor, Permanent Magnet Synchronous Machine, Reluctance motor, Hysteresis motor, AC Series Motor.	

Term Work:

The term work shall consist of record of minimum eight experiments. Four from first 6 and four from next 6 out of given below.

1. Direct loading test on alternator
2. Open circuit and short circuit test on alternator – regulation by emf and mmf method
3. Slip test on salient pole alternator – regulation by two reaction theory
4. Synchronization of alternator with bus bar
5. V-Curves of synchronous motor
6. Load test on synchronous motor
7. Load Test on three phase induction motor
8. No load & Blocked Rotor Test on three phase induction motor: Determination of Equivalent Circuit Parameters/Plotting Circle diagram
9. Measurement of Slip by Stroboscopic Method
10. Speed Control of Wound Rotor Induction Motor
11. Demo and study of three phase Linear Induction Motor
12. Study & comparison of Starters of three phase induction motor.
13. Load test on Universal Motor

15. Load Test on PMSM

Text Books:

1. Nagrath Kothari, “Electrical Machines”, Tata McGraw Hill
2. B L Theraja, “Electrical Technology”, Vol II, Chand Publications

Reference Books:	
1. Dr. S. K. Sen, “Electric Machinery”, Wiley Eastern	
2. B. H. Deshmukh, “Electrical Technology”, NiraliPrakashan	
3. M. G. Say, “Alternating Current Machines“, McGraw Hill	
4. A. S. Langsdroff, “Theory of Alternator Current Machinery”, Tata McGraw Hill	
Syllabus for Unit Test:	
Unit Test -1	UNIT – I, UNIT – II, UNIT - III
Unit Test -2	UNIT – IV, UNIT – V, UNIT - VI

Network Analysis

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 03 Hrs/Week	End Semester Examination: 60 Marks	Theory : - 03
Practical: 02 Hrs/Week	Continuous Assessment: 40 Marks	Practical : - 01
Tutorial:- 1Hr/Week	Term Work : 25 Marks, Practical: 25 Marks	Total : - 04

Course Pre-requisites:

The Students should have knowledge of

1.	Engineering Physics, Fundamentals of Electrical Engineering
2.	Engineering Mathematics (Differential equations, Integrations, Laplace Transforms, Fourier Transform

Course Objectives:

	This course introduces concepts of Network Analysis such that simplification of any complex network applying theorems, classical method (Transient response) or Laplace transform method or Fourier transform method.

Course Outcomes: The students will be able to

1.	Calculate solution of differential equation of an active (Excited by an ac source or DC source), Linear, bilateral complicated network using various network theorems.
2.	Analyze transient response of passive elements in pre-excited or unexcited conditions (initial conditions) using classical method
3.	Apply Laplace Transform Technique to analyze the behavior & response of passive elements in pre-excited or unexcited conditions (initial conditions)
4	Represent any network as two port network, Define and calculate various parameters like open circuit impedance, short circuit admittance, Transmission & Hybrid parameters and their applications in electrical domain
5	Formulate network function for a given circuit and comment about stability from poles and zeros of function.
6	Analyze a given circuit / waveform using Fourier Transform method.

UNIT - I	**Network Theorems in AC circuits**	**(06 Hours)**
	Introduction, Practical sources, Source transformations, Network reduction using Star – Delta transformation, Loop and node analysis With linearly dependent and independent sources for AC networks, Concepts of super node and super mesh. Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Millman's theorem, Reciprocity theorem, Substitution theorem, Compensation theorem, Tellegen's Theorem	
UNIT - II	**Transient Response of Passive Circuits**	**(06 Hours)**
	Introduction, transient response of series R-L and R-C circuit having DC excitation, Transient response in RL and RC circuit with sinusoidal excitation. Transient response in RLC circuit with DC and sinusoidal excitation Resonance, Coupled circuits, Scattering matrix and its application in network analysis	
UNIT - III	**Laplace Transformation and its application**	**(06 Hours)**
	Laplace transform of a derivative and integration. Laplace transform of common forcing functions, Initial and final value theorem, Time displacement theorem, Convolution theorem, Impulse response of R-L and R-C Circuit, Application of Laplace transformation technique in electric circuit analysis.	
UNIT - IV	**Two Port Networks:**	**(06 Hours)**
	Short circuit admittance, open circuit impedance, transmission and inverse transmission, hybrid and inverse hybrid parameters. Relation between parameter sets, T,π, Ladder, lattice, twin T networks. Input and out put impedance in terms two port parameters. Interconnection of networks. Symmetry and reciprocity	
UNIT - V	**Network Functions:**	**(06 Hours)**
	Network function for one port and two port networks: ladder networks, general network,	

	poles and zeros of network functions, Restriction on poles and zeros for driving point functions and transfer functions. Network synthesis of RL,RC,LC circuits	
UNIT - VI	**Fourier analysis**	**(06 Hours)**
	Exponential form of Fourier series, trigonometric form of Fourier series, symmetry in Fourier series, Frequency spectrum, properties of Fourier analysis, shifting of function, applications in circuit analysis. Fourier series representation of periodic signals, Fourier integral & Fourier transform analysis with Fourier transform. Convolution integral.	

Term Work:

The term work shall consist of record of minimum eight experiments.

1. Verification of Superposition theorem in A.C. circuits.
2. Verification of Thevenin's theorem in A.C. circuits.
3. Verification of Reciprocity theorem in A.C. circuits.
4. Verification of Millmans' theorem.
5. Verification of Maximum Power Transfer theorem in A.C. circuits.
6. Determination of time response of R-C circuit to a step D.C. voltage input. (Charging and discharging of a capacitor through a resistor)
7. Determination of time response of R-L circuit to a step D.C. voltage input. (Rise and decay of current in an inductive circuit)
8. Determination of time response of R-L-C series circuit to a step D.C. voltage input.
9. Determination of parameter of Two Port Network.
10. Determination of Resonance of R-L-C Parallel circuit
11. Determination of Resonance, Bandwidth and Q factor of R-L-C series circuit.

Text Books:

1. C. K Alexander and M. Sadiku, "Fundamentals of Electric Circuits", McGraw-Hill, Fourth Edition, 2009 (ISBN: 0077263197 / 9780077263195)
2. M. E. Van Valkenburg , "Network Analysis", PHI / Pearson Education,3rdEdition. Reprint 2002.
3. Roy Choudhury, "Networks and Systems", 2nd edition, 2006 re-print, New Age International Publications
4. F.F.Kuo, " Network analysis & Synthesis", Wayle Publication
5. A. Chakrabarti, "Circuit Theory", Dhanpat Rai Publication
6. G. K. Mithal, " Network Analysis", Khanna Publication

Reference Books:

1. Hayt, Kemmerly and Durbin, "Engineering Circuit Analysis", TMH, 7th Edition, 2010
2. J. David Irwin / R. Mark Nelms, "Basic Engineering Circuit Analysis", John Wiley, 8th edition, 2006.
3. Charles K Alexander and Mathew N O Sadiku, "Fundamentals of Electric Circuits", Tata McGraw-Hill, 3rd edition, 2009.

Syllabus for Unit Test:	
Unit Test -1	UNIT – I, UNIT – II, UNIT - III
Unit Test -2	UNIT – IV, UNIT – V, UNIT - VI

Generation, Transmission & Distribution

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 03	End Semester Examination: 60 Marks	Theory : - 03
Practical: 02	Continuous Assessment: 40 Marks	Practical : - 01
	Term Work : 25 Marks, Practical: 25 Marks	Total : - 04

Course Pre-requisites:

The Students should have knowledge of

1.	Electromagnetic energy conversion system
2.	Fundamentals of Electrical Engineering

Course Objectives:

This course introduces knowledge about electrical power generation, its transmission and distribution. The course is designed to learn different methods of power generation. Also it focuses on performance of transmission line and distribution system along with its design consideration.

Course Outcomes: Students will be able to

1.	Draw block diagram and describe the function of components of various Power Generation techniques by Conventional energy Sources.
2.	Define and analyze the significance of terms such as load factor , diversity factor etc on economics of power generation Draw block diagram and describe the function of components of various Power Generation techniques by Non Conventional energy Sources.
3.	Draw block diagram and describe the function of components of various Power Generation techniques by Non Conventional energy Sources.
4	Calculate string efficiency, sag and R, L, C parameters of different types of transmission line.
5	Represent TEE and PI model of line and analyze the performance of transmission line.
6	Explore different type of cables & its calculations along with the computation of performance of AC distribution.

UNIT - I	**Power Generation techniques by Conventional energy Sources**	**(06 Hours)**
	Introduction to energy sources, selection of site – classification – general arrangements and operations – functions of each component – types of turbines – electric generators – advantages and disadvantages - list of major power stations : of Hydro electric , Thermal and Nuclear power plants in India with capacity. Basic layout and working of diesel and gas power plant. Concept of grid, types of grids	
UNIT - II	**Load Curves and Economic Aspects**	**(06 Hours)**
	Load Curves: load curve – base load station and peak load station - demand factor – maximum demand – average demand – diversity of load – load factor – diversity factor – significance of high load factor & diversity factor – plant factor – capacity factor – connected load – load duration curve – integrated load duration curve – selection of units. Per capita energy consumption of developed & developing countries. Concept of cogeneration and captive generation.	
UNIT - III	**Power Generation techniques by Non -Conventional energy Sources**	**(06 Hours)**
	Different types of Nonconventional Energy Sources, Comparative benefits over conventional type, contribution of conventional & nonconventional energy sources, Solar energy – Its characteristics, basic concept of solar power plant, major solar power plants in India/world, Wind power plant– schematic arrangement - vertical axis, horizontal axis – electrical generator Hybrid solutions : Wind Turbine, diesel, WT-solar etc. – major wind farms in India / world, Power generation by bio gas, biomass, geothermal energy and tidal energy– its types, Magneto Hydro Dynamics (MHD), Concept of carbon credit.	
UNIT - IV	**Design of Transmission Line**	**(06 Hours)**

	Transmission Line Components and its types - Line Supports, Conductors, Insulators, Potential distribution over a string of insulators, methods of equalizing the potential, string efficiency. Sag: Catenary curve – calculation of sag and tension – effects of wind and ice loading sag templates – vibration dampers for transmission lines. Corona and interference, Various effects – Skin, Proximity, Ferranti etc. Various Parameters of Transmission Line – Resistance, Inductance and capacitance - their calculation.	
UNIT - V	**Transmission Line Performance analysis :**	**(06 Hours)**
	Circuit Representation of Transmission Line: Representation and performance of short, medium and long transmission line – Surge Impedance Loading (SIL), Characteristic Impedance, Generalized circuit constants: - Representation of tee and pi models of lines as two port networks – evaluation and estimation of ABCD constants –sending end and universal power circle diagrams.	
UNIT - VI	**Underground Cables and Distribution System**	**(06 Hours)**
	Underground Cables - Classification – construction - insulation resistance – capacitance – dielectric stress in single core cable. Grading of cables. Laying of cables – cable jointing – causes of failure – cable faults and location of faults. Distribution System – Classification – A.C. distribution connection schemes - requirements of distribution system – design consideration – design of radial, ring distributors for concentrated, distributed loads	

Term Work:

The term work shall consist of record of minimum eight experiments from below list.

1. Measurement of A, B, C, D constants of short transmission line.
2. Measurement of A, B, C, D constants of Medium transmission line.
3. Measurement of A, B, C, D constants of Long transmission line.
4. Circle diagram of medium transmission line.
5. Circle diagram of short transmission line.
6. Drawing Sheet on power generation by Conventional energy Sources
7. Drawing Sheet on power generation by non Conventional energy Sources
8. Drawing Sheet on types of insulator
9. Drawing Sheet on types of cables
10. Industrial visit to cable manufacturing
11. Industrial Visit report of HPS
12. Industrial Visit report of TPS / GAS PP
13. Industrial Visit report of WPS / Solar PP

Text Books:

1. A Course in Power System - J. B. Gupta - S. K. Kataria & Son's
2. V. K. Mehta, "Electrical Power System", S. Chand Publications

Reference Books:

1. Electrical Power - S. L. Uppal - Khanna Publication
2. Energy Technology - S. Rao, Dr. B B Panelkar - Khanna Publication
3. A Course in Power Plant Engineering - Arrora, Domkundwar - Dhanpatrai & Co. Publications
4. A Course in Electrical Power - Soni, Gupta, Bhatanagar - Dhanpatrai & Co. Publications

Syllabus for Unit Test:	
Unit Test -1	UNIT – I, UNIT – II, UNIT - III
Unit Test -2	UNIT – IV, UNIT – V, UNIT - VI

Electrical Engineering Materials		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 03Hours / Week	End Semester Examination: 60 Marks	03 Credits
	Continuous Assessment: 40 Marks	

Course Pre-requisites: Engineering Physics

The Students should have knowledge of

1.	Electrical Engineering materials

Course Objectives:

	To understand in detail the properties of interest of the materials used in Electrical Engineering

Course Outcomes: Student should able to

1.	get knowledge about conducting materials.
2.	get knowledge about magnetic materials.
3.	get knowledge about insulating materials.
4	get knowledge about dielectric & optical properties of materials.
5	get knowledge about Nano materials.
6	get knowledge about materials for electronics components

UNIT - I	**Electrical Conducting Materials**	**(06 Hours)**
	High conductivity materials : Copper, Aluminum, Iron & Steel ,Alloys of Copper Materials of High Resistivity: Materials used in precision work, Materials used for rheostat, materials used for heating devices. Electrical carbon materials, Superconductivity, Thermoelectric effects, operation of thermocouple, alloys, Thermobimetals, Study of Electrolyte.	
UNIT - II	**Magnetic Materials**	**(06 Hours)**
	Classification of magnetic materials: Diamagnetism, Paramagnetism, Ferromagnetism, Anti-ferromagnetism, Ferrimagnetism. Soft magnetic materials, Solid core materials, Sheet steel, electric steel, cold rolled grain oriented silicon steel, hot rolled grain oriented silicon steel, hot rolled silicon steel sheet. Special purpose alloy, Alloyed steels with silicon, high silicon, alloy steel for transformers, low silicon alloy steel for electric rotating machines. Common magnetic materials, Magnetic resonance, Magnetic Shielding	
UNIT - III	**Insulating Materials**	**(06 Hours)**
	Electrical properties of insulating materials, Temperature rise and insulating materials, Classification of insulating materials. Insulating materials used in modern electrical machines. Applications of insulating materials: Insulating materials for wires, Insulating materials for laminations, Insulating materials for machines, Insulating materials for transformers. Thermoplastic materials: Poly-vinyl chloride (PVC), Polyethylene, silicons, their important properties & applications. Natural insulating materials: Mica, Asbestos, Ceramic materials, Glass, Cotton, Silk, Jute, Paper, Rubber	
UNIT - IV	**Dielectric & Optical Properties of Materials**	**(06 Hours)**
	A).Dielectric Properties of Insulating Materials: Static Field ,Dielectric Parameters [Dielectric constant, Dipole moment, Polarization, Polarizability], Mechanisms of Polarizations-Electronic, Ionic and Orientational Polarization (Descriptive treatment only), Clausius Mossotti Equation, Piezo-Electric, Pyro-Electric & Ferro-Electric Materials, Dielectric Loss and loss Tangent. **B) Optical Properties of Materials & Cells used for Power Generation**: Photo-Conductivity, Photo-Electric Emission, Photo-Voltaic cells [Materials Used, Construction, Equivalent Circuit, Working and Application], Photo-Conductive cells, Photo-Emissive cells, Photo emitters, photo transistors, photo resistors, application of photo sensitive materials (CRT, Tube Light, Photo Panals)	
UNIT - V	**Nano Materials**	**(06 Hours)**

	Introduction, Concepts of Energy bands & various Conducting Mechanism in Nano-structures, Carbon Nano-structures, Carbon Molecules, Carbon Clusters, Carbon Nano-tubes, Applications of Carbon Nano-tubes, Special Topics in Nano Technology such as Single Electron Transistor , Molecular Machines, BN Nanotubes, Nano wires, Application of Nano materials in electrical engineering.	
UNIT - VI	**Materials for Electronics Components**	**(06 Hours)**
	Introduction, Resistors: Carbon composition resistors, Insulated moulded resistors, Film type resistors, Cracked carbon resistors, Alloy resistors, Metallic–oxide film resistors, Wire wound resistors, High value resistors, Non linear resistors, Varistors, Variable resistors. Capacitors: Capacitor paper, Loss tangent, Electric strength & operating stress, Mica dielectric capacitors, Ceramic dielectric capacitors, Glass dielectric capacitors, Vitreous enamel dielectric capacitors, plastic dielectric capacitors, Electrolytic capacitors, Air dielectric capacitors, variable capacitors Inductors : Construction, Air cored coils, cored coils	

Text Books:

1. A Course in Electrical Engineering Materials by S. P. Seth, Dhanpat Rai and Sons, Delhi -6.
2. Electrical Engineering Materials by K. B. Raina & S. K. Bhattacharya, S. K. Kataria & Sons, Delhi-06.
3. Electrical & Electronics Engineering Materials By Navneet Gupta , Dhanpat Rai & Co.
4. Nanotechnology - A gentle introduction to next big idea by Mark Ratner & Daniel Ratner, Pearson Education
5. Introduction to Nanotechnology by Charles P. Poole, Jr. Frank & J. Ownes (Wiley Student Edition)
6. Introduction to Nano Science & Technology – Chattopadhyay – PHI Publication

Reference Books:

1.Electrical Engineering Materials by C. S. Indulkar & S. Thiruvengadam, S. Chand & Com.Ltd
2. Electrical Engineering Materials by S. P. Chalotra & B. K. Bhatt, Khanna Publishers
3. Introduction to Material Science for Engineering by James F. Shackelford, M.K. Muralidhara, Pearson Education, Sixth Edition.
4. Insulation Technology Course Material of IEEMA, Ratner, Pearson Education.
5. Electrical Engineering Materials, Dekkar, PHI Publications.

Syllabus for Unit Test:	
Unit Test -1	UNIT – I, UNIT – II, UNIT - III
Unit Test -2	UNIT – IV, UNIT – V, UNIT - VI