Department of Electrical Engineering

Course Structure and Syllabus for B. Tech. Program

Dr. Babasaheb Ambedkar Technological University
Lonere (Raigad) – 402 103 Maharashtra

Teaching & Evaluation Scheme
Semester – I : B. Tech. Electrical Engineering

Code	Course	Lecture	Practical	Credits	MSE	ESE
BH101	Basic course in Communicative English	3		6	30	70
BH102	Engineering Mathematics – I	4		8	30	70
BH103	Engineering Physics – I	3		6	30	70
BH103L	Engineering Physics – I Laboratory		2	2	50	
BH104	Engineering Chemistry – I	3		6	30	70
BH104L	Engineering Chemistry – I Laboratory		2	2	50	
EM105	Engineering Mechanics	3		6	30	70
ID106	Energy and Environmental Engineering	2		4	30	70
WS107	Workshop Practice		4	4	50	
XB108	Branch Specific Course*	3		6	30	70
XC109	NSS/NCC/Sports/Arts					
	TOTAL	21	8	50	850	

*EL108 Introduction to Electrical Engineering, for Electrical Engineering Department

Teaching & Evaluation Scheme
Semester – II : B. Tech. Electrical Engineering

Code	Course	Lecture	Practical	Credits	MSE	ESE
BH201	Basic course in Human Rights	2		4	30	70
BH202	Engineering Mathematics – II	4		8	30	70
BH203	Engineering Physics – II	3		6	30	70
BH203L	Engineering Physics – II Laboratory		2		50	
BH204	Engineering Chemistry – II	3		6	30	70
BH204L	Engineering Chemistry – II Laboratory		2	2	50	
CL205	Basic Civil Engineering	2		4	30	70
ME206	Basic Mechanical Engineering	2		4	30	70
ME207	Engineering Graphics***	1		2	30	70
ME207L	Engineering Graphics Laboratory		4	4	50	
XA208	Branch Specific Programming and Software**	3		6	30	70
XC209	NSS/NCC/Sports/Arts					
	TOTAL	20	8	48	950	

**EL208 Electrical Engineering: Programming and Softwares, for Electrical Engineering Department
*** Four Hours End Semester Examination

Teaching & Evaluation Scheme
Semester – III : B. Tech. Electrical Engineering

Code	Course	Lecture	Practical	Credits	MSE	ESE
BH301	Engineering Mathematics – III	4		8	30	70
EE302	Numerical Methods	4		8	30	70
EE303	Network Analysis	4		8	30	70
EE304	Network Analysis Laboratory practices		2	2	25*	25#
EE305	Electrical Machines – I	4		8	30	70
EE306	Electrical Machines–I Laboratory Practices		2	2	25*	25#
EE307	Electrical Measurements	3		6	30	70
MEEE308	Fluid Mechanics & Thermal Engineering	3		6	30	70
EE309	Seminar report & presentation			4	20*	30#
EE310	NSS/NCC/Sports/Arts					
	TOTAL	22	4	52	250	500

* Term work evaluation # Practical/Viva Voce

Teaching & Evaluation Scheme
Semester – IV : B. Tech. Electrical Engineering

Code	Course	Lecture	Practical	Credits	MSE	ESE
EE401	Electrical Machines – II	4		8	30	70
EE402	Power System – I	4		8	30	70
EE403	Instrumentation	4		8	30	70
EE404	Electronic Devices and Circuits (E D C)	4		8	30	70
EE405	Elective – I	4		8	30	70
EE406	Electrical Machines – II Laboratory Practices		2	2	25*	25#
EE407	Meas. & Inst. Laboratory Practices		2	2	25*	25#
EE408	Electrical Workshop		2	2	25*	25#
EE409	NSS/NCC/Sports/Arts					
	TOTAL	20	6	46	225	425

* Term work evaluation # Practical/Viva Voce

Elective - I

1. Introduction to Non conventional Sources of Energy
2. Electrical Engineering Materials
3. Ergonomics
4. Power Plant Engineering

Teaching & Evaluation Scheme
Semester – V : B. Tech. Electrical Engineering

Code	Course	Lecture	Practical	Credits	MSE	ESE
EE501	Alternating Current Synchronous Machines	4		8	30	70
EE502	Power System Operation and Control	4		8	30	70
EE503	Microprocessor Microcontrollers	4		8	30	70
EE504	Electrical Installation and Estimation (E I E)	3		6	30	70
EE505	Elective – II	4		8	30	70
EE506	AC Syn. Machines Laboratory Practices		2	2	25*	25#
EE507	Power System Laboratory Practices (I & II)		2	2	25*	25#
EE508	Microcontroller Laboratory Practices		2	2	25*	25#
EE509	Industrial Training					
EE510	NSS/NCC/Sports/Arts					
	TOTAL	19	6	44	225	425

* Term work evaluation # Practical/Viva Voce

Elective - II

1. Industrial Instrumentation
2. Introduction to Non-conventional Energy Sources (Introduction To Biomass and Geothermal Energy)
3. Biomedical Instrumentation

Teaching & Evaluation Scheme
Semester – VI : B. Tech. Electrical Engineering

Code	Course	Lecture	Practical	Credits	MSE	ESE
EE601	Switch Gear and Protection	4		8	30	70
EE602	Power Electronics	4		8	30	70
EE603	Principles of Electrical Machine Design	4		8	30	70
EE604	Control Systems – I	4		8	30	70
EE605	Elective – III	4		8	30	70
EE606	SGP Laboratory Practices		2	2	25*	25#
EE607	Power Electronics Laboratory Practices		2	2	25*	25#
EE608	Electrical Workshop Laboratory Practices		2	2	25*	25#
EE609	NSS/NCC/Sports/Arts					
TOTAL		20	6	46	225	425

* Term work evaluation # Practical/Viva Voce

Elective - III

1. Industrial Automation and Control
2. Design of Experiments for Engineers and Managers
3. Artificial Neural Network

Teaching & Evaluation Scheme
Semester – VII : B. Tech. Electrical Engineering

Code	Course	Lecture	Practical	Credits	MSE	ESE
EE701	Special Purpose Electrical Machines	4		8	30	70
EE702	Control System - II	4		8	30	70
EE703	Control Drives	4		8	30	70
EE704	Elective – IV	4		8	30	70
EE705	Introduction to Power System Component Modeling	4		8	30	70
EE706	S.P.E.M. Laboratory Practices		2	2	25*	25#
EE707	Control System Laboratory Practices (I & II)		2	2	25*	25#
EE708	Seminar		2	4	25*	25#
EE709	Project Phase - I		2	6	50*	50#
EE710	Industrial Training					
EE711	NSS/NCC/Sports/Arts					
	TOTAL	20	8	54	275	475

* Term work evaluation # Practical/Viva Voce

Elective – IV

1. Power Quality Issues
2. Artificial Intelligence
3. Entrepreneurship Development
4. HVDC Transmission and FACTs

Teaching & Evaluation Scheme
Semester – VIII : B. Tech. Electrical Engineering

Code	Course	Lecture	Practical	Credits	MSE	ESE
EE801	Electrical Utilization	4		8	30	70
EE802	Energy Audit & Conservation	4		8	30	70
EE803	High Voltage Engineering	4		8	30	70
EE804	Elective – V	4		8	30	70
EE805	Power System Stability and Analysis	4		8	30	70
EE806	Electrical Utilization – Laboratory practices		2	2	25*	25#
EE807	HV Engineering Laboratory Practices		2	2	25*	25#
EE808	Controlled Drives Laboratory Practices		2	2	25*	25#
EE809	Project Phase – II		4	12	50*	50#
EE810	NSS/NCC/Sports/Arts					
	TOTAL	20	10	58	275	475

* Term work evaluation # Practical/Viva Voce

Elective – V

1. Microcontroller And Interfacing
2. Robotics and Automation
3. Digital Signal Processing
4. Elements of Project Management

SEMESTER – III

(BH301) ENGINEERING MATHEMATICS-III

Unit 1 Power series method for solution of ordinary differential equation; Legendary equation & Legendary polynomial, Bessel's equations, & Bessel's functions of first & second kind, Orthogonally, Sturm- Liouville problems.

Unit 2 Laplace transformation

Unit 3 Inverse transformations, shifting on s & t axes, Convolutions, Partial fractions.

Unit 4 Fourier Series, Half range expansions, Approximation by trigonometric polynomials, Fourier Integrals.

Unit 5 Partial Differential Equations First & second order partial differential equation with variable coefficients, wave equation & Heat equation in one & two Dimensions (criterion of co-ordinates only) Transform Technique in p.o.d.e. & p.d.e.

Unit 6 Infinite sequence &series of numbers, Improper integrals, Cauchy criterion, Test of convergence, Absolute & conditional convergence, series of functions, Uniform convergence, power series, Radius of convergence

References

1. Grewal B. S., "Higher Engg. Mathematics", (Khanna Publications)
2. Kreyszig F, "Advance Engg. Mathematics", (Wiley Publications)
3. Wartikar P N & J N, "Engg. Mathematics (Vol I & II)", (Poona Vidyarthi Griha publications)

Subject : EE302 – Numerical Methods

Course Objectives :

1. To prepare students for successful career in industries, for Post Graduate programmes and to work in research institutes.
2. To understand different numerical techniques used for solving algebraic and transcendental equations.
3. To understand numerical integration and differentiation techniques, numerical methods to solve a system of linear equations.

(EE302) NUMERICAL METHODS

Unit 1 Solution of equation for engineering design and analysis and numerical research for roots of algebraic and transcendental equation: introduction, Taylor's series expansion of function, digital computers, number representation, floating point and fixed point, algorithms and flow charts, error considerations, sequences, incremental search, Bisection method, method of false position, Newton Raphson method, modified Newton Raphson method, Secant method, Complex Roots of equations, practical application

Unit 2 Method to solve linear simultaneous equation: properties of matrices, Gaussion Elimination, Pivoting Techniques, Gauss-Jordan method, matrix factorization Techniques, Jacobin method, Gauss-seidel method.

Unit 3 Function approximation or interpolation : Discrete least squares approximation, Least square function approximation. Interpolation with divided differences, Langrange polynomials, Cubic spline approximation

Unit 4 Numerical Integration and Differentiation: Introduction, Trapezoidal rule, Simpson's rule, Newton-cotes formulas, Romberg Integration, Gauss Quadrature, Central Difference, Backward difference, Error consideration

Unit 5 Matrix Eigenvalue problems and solution of equation
Gerschgorin circle theorem, characteristics equation, power method, Inverse power method, Jacobin's method, Householder-Q, L method, Householder-Q, R method, Newton's method for engineering design and analysis

Unit 6 Numerical solution of ordinary differential equation and Introduction to Partial differential equation : Introduction, Runge Kutta method, Euler's method, elliptic partial differential equation, parabolic partial differential equations, Hyperbolic partial differential equation.

References

1. M.K., Iyengar S.R.K, Jain R. K,"Numerical Methods for Scientific and Engineering Computation", .Jain 3/e, New Age International Ltd.,
2. Bhat R B, Chakraverty S ,"Numerical Analysis in Engineering" –,. Narosa Pub
3. BiswanNath, Datta,"Numerical method for Linear Control System",- Eleasever Pub

Course Outcomes:

A. Learner will be able to solve algebraic and transcendental equations by using numerical techniques.
E. Learner will be able to compare different numerical techniques used for various purposes.
H. Learner will also be able to choose a proper one as per the requirement of the problem.
I. Learner will be able to solve a system of linear equations with any number of variables using different direct and iterative numerical techniques.
K. To mold students professionally by course contents and sufficient problem solving exercises and to acquaint them with different types of numerical techniques.

Table 1 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	B	C	D	E	F	G	H	I	J	K
1	√				√						√
2	√				√			√			
3									√		√

Subject : EE303 – Network Analysis

Course Objectives:

1. To understand the fundamental behavior of basic elements (R, L, C), their mathematical models and operation with basic theorems.
2. To understand various electrical network topology, formation of equations and their solution techniques.
3. Study to understand various effects of these elements in AC network and their quality parameters.
4. The content of this course gives platform to the power system and control world and innovative ideas to ensure the knowledge of real time applications which helps students to stand them in Indian and multinational power control industries.

(EE303) NETWORK ANALYSIS

Unit 1 Active & Passive Circuit Element: Independent & dependent voltage & current sources, R, L, C & mutual inductance circuit parameters, Their mathematical modes, Voltage current power relations.
Classification of element: Lumped distributed, Linear & non-linear, Unilateral, Bilateral, Time invariant & variant, Pace invariant & variant, Super position, Thevenin's, Norton's Reciprocity, Maximum power transfer, Substitution, Tellegen's theorem.

Unit 2 Network Equations: Network topology, Graph, Tree, Branches, Chords, Equilibrium equation on loop basis & node basis Number of network equation required, Choice between nodal & loop analysis, Source transformation, Network mutual inductance, Dot conventions, Concept of super mesh, Super node Concept of duality & dual networks.

Unit 3 Solution of Network Equations: Classification solution of first, Second order differential equations of series & parallel R-L, R-C, R-L-C circuits, General & particular solutions, Particular integral & complimentary functions, Time constant, Mathematical analysis of circuit transients, initial conditions in network, Procedure of evaluality, Conditions in network problems, Solution of D.C. resistive network & A. C. sinusoidal steady state networks, Writing loop equations, Node equations directly in matrices form. Numericals.

Unit 4 Application of Laplace's Transform: Solution of differential equation using laplace transform, Unit step, Impulse & ramp functions, Laplace transform of singular & shifted function, Convolution integral, Concept of complex frequency, Transform impedance & transform admittance, Series & parallel combination of these transform networks.

Unit 5 Two port network: Terminals& terminal pairs, Driving points & transfer admittance, Transfer functions, Concept of poles & zeroes, Two port networks, Z, Y & the transmission parameters relationship between parameter sets.

Unit 6 Sinusoidal Steady State A. C. Circuit: R-L-C series circuits, Series resonance Variation of Z with frequency, maximum value of V_C & V_L, Magnification, Bandwidth, Q factor.
Parallel Resonance: Resonance frequency for tank circuit frequency, Locus diagram of series R-L, R-C with variable R & X.

Filter: Introduction classification, Low pass, High pass, Band pass & band reject filter, active & passive filters. Application of Fourier series, Expansion for periodic & non-sinusoidal waveforms.

References

1. M.E Van Valcanburg, "Network Analysis",(Asia Publication House)
2. Scolt David, "Network Analysis Vol I, II & III"

Course Outcomes:

A. Students will be able to apply knowledge of mathematics and engineering to formulate problems.
B. Students will be able to solve various electrical power network problems.
E. Learners will apply fundamental knowledge of network theory to formulate power system problems.
J. Students will understand the theme of life-long learning process.
K. Students will understand applications of various networks in power system analysis and its improvement techniques.

Table 2 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√	√									
2	√	√			√						
3	√	√									
4									√		√

Subject : EE305 – Electrical Machines – I

Course Objectives:

1. Learner can able to apply his knowledge in the area of magnetic field fundamentals, investigate relation between different parameters of transformer.
2. Understand fundamentals related to DC machines (generators, motors), its types, and different characteristics. Derive relation between different parameters, and applications of these machines.

3. Understand fundamentals related to 3-ph AC machines (induction motor), characteristics, different parameters and their relations. Applications of these machines.
4. Understand fundamentals related to 1-ph AC machines, their types, characteristics, and applications of these machines.

(EE305) ELECTRICAL MACHINES – I

Unit 1 Three-phase transformer: Review of construction, standard connections (Star-star, star-delta, delta-star, delta-delta), their characteristics, features, V-I relationship, V-V connection, phasor diagrams & numerical, Scott connection, Phasor diagram & numerical, parallel operation of 3ϕ transformer (Theory only), concept of all day efficiency with numericals, autotransformer, Instrument transformer, various errors in instrument transformer, advantages & Disadvantages, (testing of transformers).

Unit 2 D. C. Machines: Construction, aspects of D. C. machine (Including armature & magnetic circuit), Basic principle of operation as a Motor& generator, different types of D. C. machines a) Series, b) shunt, c) compound], armature reaction, commutation.

D. C. Generators: e.m.f. equation, losses & efficiency, condition for maximum efficiency, Power stages, numericals, characteristics of D. C. Generators, open circuit, internal & External characteristics, voltage built up process, concept of original resistance of field, Load for series & shunt generator, concept of original speed, numericals.

Unit 3 D. C. Motors: significance of back e.m.f., torque equation, numericals, characteristics of D. C. Motors (torque-current, speed-current, torque-speed characteristics), losses & Efficiency, Condition for maximum efficiency, power developed, power stages & numericals.

Unit 4 Armature reaction in D. C. Generator, demagnetising & cross magnetizing m.m.f.s & their estimation, remedies to over come armature reaction (extra turns on main poles, compensating winding), process of commutation, causes of bad Commutation &Remedies, (resistance commutation, e.m.f. commutation, interpoles).

Unit 5 Three phase induction motor: operating principle, construction, production of RMF with 3-ph & 2-ph supply, concept of slip, frequency of rotor current, relationship between Torque & power factor, starting torque equation, starting torque of squirrel cage & slip ring Induction motor, condition for maximum starting torque, effect of supply voltage on starting torque, rotor e.m.f. & reactance under running condition, relationship between Full load torque, maximum torque & starting torque with numericals, torque-slip curves for induction motor, torque-speed curves, plugging, induction motor operation as Generator (theory only), power stages, torque, mechanical power & rotor operation, Concept of synchronous watt, numerical based on above.

Unit 6 Single phase motors: double field revolving theory, making single-phase induction motor self starting, capacitor start & capacitor run motor, shaded pole motor, repulsion induction motor, speed-torque curves of above motors & their applications. Universal motor: principle of working, characteristics & applications.

References

1. Bhattacharya S. K, "Electrical Machines",(Tata McGraw Hill Publications)
2. Kothari Nagrath, "Electrical Machines", (Tata McGraw Hill Publications)
3. Fitzaralda, "Electrical Machines", (Tata McGraw Hill Publications)

Course Outcomes:

A. Fundamentals related to magnetic field will help students to learn fundamentals of electrical machines. Learner will apply knowledge of mathematics to calculate different parameters of transformer, machines, investigate relation between different parameters.

E. Will encourage students to learn its usefulness and impact in core electrical engineering domain.
F. Basic platform related to machines will help in understanding future courses like AC Synchronous Machines, Special Purpose Machines.
H. Students will understand impact of technological development used by society through practical applications of electrical machines.
K. It will encourage the students to learn and work in core electrical engineering field.

Table 3 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√				√	√					
2	√				√			√			
3						√		√			
4	√										√

Subject : EE307 – Electrical Measurements

Course Objectives:

1. To understand the principle of operation & working of different electrical measuring instruments.
2. To understand importance of measuring and monitoring different parameters, their importance in real time control applications in different fields.
3. The content of this course gives platform to the instrumentation and control world and innovative ideas to ensure the knowledge of real time applications which helps students to stand them in Indian and multinational industries.

(EE307) ELECTRICAL MEASUREMENTS

Unit 1 General: International system, Units, Dimensions of electrical quantities, Absolute measurement of current and resistance, Measurement of Resistance: Classification and methods of measurement, Ohmmeter, Ratio-meter, DC Potentiometer, Whetstone bridge, Kelvin's double bridge, Measurement of high resistance, Measurement of earth resistance and resistivity, Bridge megger, Ductar Megger, Measurement of insulation resistance.

Unit 2 AC Potentiometer: Types, construction, and operation, Applications, AC Bridges: Classification, Maxwell, Anderson, Earey Foster, Schering, Weins and Campbells Bridges, accessories, advantage and limitations, Instrument Transformer: Theory, expression for ratio and phase angle errors, design considerations and testing and precautions in using instrument transformer.

Unit 3 Ammeters and Voltmeters: Construction, Principle of operation, Torque equation, Error of P.M.M.C, Moving iron, Electrodynamic and electrostatic instruments, extension of ranges using shunt and Multipliers, Magnetic Measurements: Flux meter, B-H curve of a ring specimen, Hysteresis loop, Permanence, Iron loss test at power frequency, Effect of voltage, Frequency & form factor on iron loss, separation of iron losses, Epstein square & Lloyd fisher square.

Unit 4 Measuring instrument characteristics: Static & dynamic characteristics of instruments, accuracy, linearity, reproducibility, sensitivity, resolution, speed of response, Galvanometer - Construction, Deflecting, controlling, damping, balancing system, D-Arsenal, ballastic, vibration Galvanometers, Polyphase Systems & Energy meters, Generation of three phase voltage, balance & unbalance system, voltage, current & power relations in star & delta connections, applications of star & delta connections, Numericals.

Unit 5 Wattmeter - Construction, Principles of operation of electrodynamic & induction type wattmeter, Errors & their compensation construction, measurement of power in three phase circuits by three, two & one wattmeter, Determination of power factor from wattmeter readings in 2 wattmeter method, Numericals.
Energy meter - Principles of operation & torque equation of induction type energy meter, Error & adjustments.

Unit 6 Special Measuring Instruments: Construction & principle of operation of single & three phase power factor meters, Frequency meters, Synchroscope, Trivectormeter & maximum demand indicator.

References

1. Golding E. W,"Electrical Measurements & Measuring instruments",(Tata McGraHill Publication)
2. Sawheny A. K, "Electrical Measurements", (Khanna publications)
3. Bhide, Jalgaonkar, **"**Electrical Technology and Instruments"

Course Outcomes:

A. Students will be able to select specific instrument for specific measurement function.
B. Students will able to interpret data recorded by various instruments.
E. Learners will apply fundamental knowledge of instrument characteristics for solving engineering problems.
H. Students will understand different types of standards; methods of calibration used in measurements and also will get idea about statistical and regression analysis.
J. Learners will able to use modern equipments like CRO, DSO.
K. Students will understand functioning, specification, and applications of measuring and signal analyzing instruments.

Table 4 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√	√									
2		√						√			√
3					√			√		√	√

Subject : MEEE308 – Fluid Mechanics and Thermal Engineering

Course Objectives:

1. To mold students to understand fundamentals of interdisciplinary subjects in engineering and their importance.
2. Learner will understand fundamentals of fluid mechanics, compressors, IC engines.
3. Learner will understand fundamentals of air conditioning, refrigeration technology.

(MEEE 308) FLUID MECHANICS & THERMAL ENGINEERING

Unit 1 Introduction to properties of fluids & hydraulic measurements (pressure at plane & curved surfaces, criteria of pressure), Fluid kinematics and dynamics & simple numerical.

Unit 2 Flow through pipe Laminar flow, Haugen Poisellie's equation Turbulent flow, Darcy Weisbach formula, Friction factor, use of Moddys Diagram only, Pipes in series & parallel, minor losses. Introduction to reciprocating and centrifugal pumps, their characteristics and applications.

Unit 3 Internal Combustion Engines: Introduction to First Law & second Law of Thermodynamics, Concept of Entropy & Enthalpy Classification Otto, Diesel & air-fuel cycles, Constructional details of two stroke, four stroke engines, study of various systems such as fuel supply, ignition cycle, over heating, cooling, lubrication, calculation of IP, BP, MEP, efficiencies, heat balance, engine trial, performance, gas turbine, classification, cycles, performance improvement.

Unit 4 Air compressors: Classification, principle of operation of reciprocating & rotary compressors, Constructional details of single & multi stage compressor, work input, P-V diagram, efficiencies, improving compressor performance, reciprocating type only, use of compressed air.

Unit 5 Refrigeration & Air conditioning:
Refrigeration: Different systems, principle of cycles of operations of vapour compression & vapour absorption systems, COP calculations of vapour compression refrigeration system, refrigerants, desirable & undesirable properties, application of refrigeration.

Unit 6 Air conditioning: Psychrometry, DBT, WBT, RH, Psychometric chart, air conditioning processes such as heating, cooling, humidification, dehumidification, study of central air conditioning plant & its control, application of air conditioning.

References

1. Joel Reyner, "Engineering Thermodynamics",(Longman Publications)
2. Nag P. K., "Engineering Thermodynamics", (Tata McGraw Hill Publications)
3. Arora C.P, "Refrigeration & Air Conditioning", (Tata McGraw Hill Publications)
4. Eastop T. D. & Mcconkey A., "Applied Thermodynamics For Engineering Technologists" (Longman Publications)
5. Modi P.N & Seth S.M, "Hydraulic Fluid Mechanics",(Standard Book House Publications)
6. Lewitt W., "Hydraulic & Fluid Mechanics",(Sir Issac Pitman Publications),10th Edition

Course Outcomes:

A. Students will able to apply knowledge of science and engineering.
D. Learner will understand the need of knowledge of interdisciplinary courses in engineering.
G. Learner will able to work in multidisciplinary teams and communicate effectively.
I. Students will be developed professionally by course contents and acquainted with different types of mechanical systems and its importance in electrical engineering.

Table 5 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√			√			√		√		
2				√					√		
3				√					√		

SEMESTER – IV

Subject : EE401 – Electrical Machines – II

Course Objectives:

1. Learner can able to apply his fundamental knowledge gained related to electrical machines (DC motors) for their various controls.
2. Understand starting methods of electrical machines (AC and DC) their importance and practical performance.
3. Understand the importance of testing of machines (DC generators and motors, 3-ph induction motors, 1-ph motors), various types of tests and their applications.
4. Performance analysis using analytical and graphical methods through practical performance.
5. Apply fundamental knowledge gained for analysis of various effects. Importance and impact of various specialized tests on performance of machines.

(EE401) ELECTRICAL MACHINE – II

Unit 1 Performance & testing of D. C. Machine: Factors controlling the speed of D.C. series shunt & compound motor, their speed control methods (flux control, armature control), electric braking of shunt & series motors (Rheostatic, plugging), Necessity of starters, shunt & series motor starters (Two point, three point & Four point starters).

Unit 2 Testing of D.C. Motors: Importance of testing, break test, Swinburn's test, Hopkinsons test, Field test, retardation test. Application of D.C.motors. Parallel operation of D.C. Generators with numericals & the field of application.

Unit 3 Operating characteristics of three-phase Induction motor: Computation & circle diagram, principles, experimental test required for plotting circle diagram, construction of circle determination of performance parameter like full load & maximum quantities.

Unit 4 Starting of induction motor, squirrel cage motor starters (primary resistors, auto transformer, star-delta starters), slip-ring motor Starters (rotor resistance starter), crawling of induction motor, magnetic locking (cogging), double cage motors, equivalent circuit.

Unit 5 Speed control methods, control from stator side: by applied voltage, frequency, No. of stator Poles: Control from rotor side: rotor rheostat, cascade, EMF injection in rotor circuit.

Unit 6 Testing of three-phase induction motor: heat run test, HV test, OC test, SC test, and Megger test.
Different tests on single-phase induction motor.

References

1. Say M. G., "Design & performance of A.C. Machines", (Book Publications,3rd edition)
2. Clayton E. W., "Design & Performance of D. C. Machines", (Pitman Publications,2nd edition)
3. Bhimra P. S., "Electric Machines", (South Ex Publications, New Delhi)

Course Outcomes:

A. Students will be able to apply various techniques (conventional as well as advance) for control of electrical machines (AC and DC).
C. Can apply starting methods to control problems related to starting of machines and its impact on other parallel electrical networks.
E. Learner will apply knowledge of mathematics to analyze performance of machines through different practical / laboratory tests.
F. Can apply graphical methods to evaluate performance of machines using fundamental tests.
H. Students will understand importance and impact of specialized tests, their standards requirements and benefits to the society, user and manufacturer.
K. It will encourage the students to work in core electrical engineering field like testing, maintenance, installations etc.

Table 6 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	B	C	D	E	F	G	H	I	J	K
1	√				√	√					
2	√				√			√			
3						√		√			
4	√				√						√
5			√			√		√			√

Subject : EE402 – Power System – I

Course Objectives:

1. Learners will able to understand electrical power system network, various types of power plants and their functioning.
2. Learner will understand working principle of various equipments / elements of power system network.
3. The learner will understand fundamentals related to transmission, distribution lines and networks, mechanical design, associated problems with possible solution techniques.

(EE402) POWER SYSTEM – I

Unit 1 Load and Energy survey, load duration curve, plant factor and plant economics. Introduction to different sources of energy. Construction, principle and working of different thermal power plants with neat block diagram of main parts, fuel economization, for thermal power plants based on Coal, Oil and nuclear energy.
Hydroelectric Power Plant: Advantages and limitations, selection of site, hydrological cycles and hydrographs, storage and pondage, essential elements of hydroelectric plant, classification, different types of turbines and their selection, layout of hydro-station, simple numerical.

Unit 2 Major Electric Equipments: Descriptive treatment of alternator exciter & excitation systems, Transformers, Control panels, Metering & other control room equipments.
Inductance: Definition, Inductance due to internal flux of two wire single phase line of composite conductor line, Concept of GMD, Inductance of three phase line with equal & unequal spacing, vertical spacing.

Unit 3 Capacitance: Concept of electric field, Potential difference between two points in space, Effect of earth's surface on electric field, Computation of capacitance of single phase, three phase transmission lines with & with out symmetrical spacing for solid & composite conductors.

Unit 4 Transmission: Types of conductors, Choice of conductor materials, Stranded copper & ACSR conductor, Insulation consideration, Different types of insulator, supports, distribution of voltage across the insulator string, String efficiency, skin effect, Ferranty effect, proximity effect.

Unit 5 Current and Voltage relation: Representation of short, medium & long transmission lines, P. U. quantities, evaluation of ABCD parameters and surge impedance loading, power flow through transmission line, circle diagram, evaluation of relation between sending and receiving end current & voltage, Interpretation of transmission line equation, Numericals, Line current, % regulation, Transmission efficiency, numericals based on above.

Unit 6 Mechanical Design of Transmission Line: Effect of wind & ice coating on transmission line, sag due to equal & unequal supports, with their derivation, Numericals.
Corona: Phenomenon of corona, factors affecting the corona, Power loss & disadvantages of corona.

References

1. Gupta B. R. " Power Plant Engineering".(Eurasia publications)
2. Nag P. K. " Power Plant Engineering",(Tata McGraw Hill Publications)
3. Kothari Nagrath, "Electric Power System", (Tata McGraw Hill Publications)
4. Wadhva S. L.,"Electric Power System",(Tata McGraw Hill Publications)
5. Stevension W. B., "Power System", (English Language Book Society publications)

Course Outcomes:

A. Students will able to apply his knowledge of mathematics and network theory in solving problems related power system networks.
B. Students will able to analyze data related to various conditions in power system network.
D. Students will able to understand the importance interdisciplinary subjects and teamwork.
E. Students will able to formulate problems related to power network for optimum solution.
F. Students will also understand the social and ethical responsibility while studying power system network in transmission and distribution field.
H. It will encourage the students to work in core electrical engineering field of power system engineering.
K. The knowledge of real time applications will help students to stand them in Indian and multinational power sector industries.

Table 7 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√	√			√						√
2				√				√			
3	√	√				√					

Subject : EE403 – Instrumentation

Course Objectives:

1. To understand different types of standards, methods of calibration used in measurements also to get idea about statistical and regression analysis.
2. To understand the principle of operation & working of different electronic instruments.
3. To understand the principle of operation & working of different transducers, applications in the field of instrumentation and control.
4. The content of this course gives platform to the instrumentation and control world and innovative ideas to ensure the knowledge of real time applications which helps students to stand them in Indian and multinational industries.

(EE 403) INSTRUMENTATION

Unit 1 Introduction: Basic measurement and instrumentation systems and its representation, Standards and calibration, Symbols, Static and dynamic characteristics, Specifications and selection of instruments, System equations, Dynamic response, Systematic and random errors and their evaluation.

Unit 2 Digital Instrumentation: Voltage and Current measurement, Digital voltmeter (DVM), Principle of A.C. voltage measurement, Average, Peak, R.M.S. responding detectors, Direct current probes, A.C. current probes, Digital frequency measurement, Phase measurement using X-OR phase detection, Digital power measurement using PWM techniques, Transducers for above measurements which give 4 to 20 mA or 0 to 10 mA output range.

Unit 3 Magnetic Measurements: Induction B-probe coil with integrator, Galvanometric devices using Hall effect, Field strength, H-saturation core transducers, Foester probe, Resistivity of Ferro-resistive metal layers, guard probe, ferro-magnetic materials, Investigation, Hysteresis loop, Communication curve, KOEPSEL direct measurements & separation of iron losses.

Unit 4 Transducers – Different types, selection, application for measurement of force, motion, torque, power, pressure, temperature, flow, acoustic & signal analysis. Disturbance Capacitive and magnetic disturbances, Attenuation with shielding, Long term disturbances, Co-axial cables, Ground and supply loop disturbances, Guard protection.

Unit 5 Compensation: Voltage compensation, Principle of operation, Automatic, Analog, manual, Digital & Automatic digital compensation, Current compensator, Principle of operation & its use as ohmmeter.

Unit 6 Microprocessor Based Measurements: Micro controller, Microprocessor, Auxiliary hardware, Interface logic, Selection and application of microprocessor, Function of typical microprocessor, Microprocessor based instruments, IEEE 488 bus, Microprocessor controlled instruments.

References

1. Cooper.W. D– Electromagnetic Instrumentation & Measurement Techniques.(Prentice Hall Of India).
2. Rangan, Mani & Sharma – Instrumentation Devise & System.(Tata Mcgraw Hill).
3. Boweles .J.– Digital Instrumentation.(Mcgraw Hill)

Course Outcomes:

A. Students will understand different types of standards; methods of calibration used in measurements and also will get idea about statistical and regression analysis.
B. Students will able to interpret data recorded by various instruments.
E. Learners will apply fundamental knowledge of instrument characteristics for solving engineering problems.
G. Students will be able to apply communication measurement techniques to transmitter and receiver.
H. Learners will gain knowledge of different oscilloscopes like CRO, DSO in measurements and recording instrumentation.
K. Students will get introduction to computer controlled test measurements.

Table 8 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√	√			√						√
2							√	√			√
3					√			√			
4		√					√				√

Subject : EE404 – Electronics Devices and Circuits

Course Objectives:

1. To know different types of commonly used electronics devices, their principle of working, construction and operating characteristics.
2. To understand the concept of Op-Amp such as differential amplifier modes analysis using *r* parameters, ideal Op-Amp parameters, fundamentals and various stages in the Op-Amp.
3. To design Op-Amp based linear and non-linear applications to the specified functionality.
4. To design small DC supply circuits, digital circuits using logic gates for different applications.
5. To know different types of memories and its mapping, digital circuits for logical decisions.

(EE 404) ELECTRONIC DEVICES AND CIRCUITS

Unit 1 P-N Junction Diode: Principle of operation & characteristics, point contact diode, Photo diode, LED, Schottky diode, Junction breakdown & zener diode, Junction capacitance, Switching characteristics of diode, Half wave, Full wave rectifiers, Evaluation of performance, Analysis of filter circuits for rectifier, Diode clipping & clamping circuit.

Unit 2 Junction Transistor : Principle of operation & characteristics, Different parameter, h-parameter equivalent circuit, parameter calculation, Transistor as a switch, Transistor biasing

Unit 3 Transistor as an Amplifier, load line, Small signal low frequency analysis of single stage amplifier in different configuration, High frequency equivalent circuit of transistor (hybrid pi), Cascade amplifier, High input resistance circuits-C coupled amplifier Frequency response, Definition of 3 db bandwidth, Effect of cascading on gain & BW, Classification of amplifiers.

Unit 4 Block diagram of operational amplifier, Properties of ideal operational amplifier, Explanation of different terms appearing in OP-Amp application (offset, bias, quantities, PSRR, CMRR, A_d, A_C, Slew rate etc.), Operation of circuit diagram of OP-Amp using discrete components & I.C. diagram, Different types of current of current sources in I.C. technology, frequency response of OP-Amp, OP-Amp parameters & minimization technique of temperature effect, Inverting & Non-inverting operation of Op-Amp & analysis for AG, RI, RO, Linear & non-linear circuit application of OP-Amp

Unit 5 78XY series voltage regulators, Typical application for positive, negative & floating type voltage regulators, Current boosting, Switching type regulators, Protection used in voltage regulators, IC 555, IC 565 parameters operations & applications, Boolean algebra, D'Morgans theorem, OR, AND inverter gate positive & negative logic, Simplification of Boolean expressions (Use of karnaugh mapping).

Unit 6 Logic families, TTL, CMOS. IC memory operation such as RAM, ROM, PROM, EPROM, EPROM-2732 pin connection, Block diagram.
Half & full adder, Half & full substractor, Decoders, Multiplexers, S-R, J-K, flip flops, Race round condition, Master slave J-K Flip Flop, Counters (Asynchronous & synchronous type)

References

1. Malvino Albert," Principles of Electronics", (Tata McGraw Hill Publications)
2. Mottershed Allen," Electronic devices and circuits", (Prentice Hall of India Pubs)
3. Halkies Millman, "Electronic devices and circuits"(Tata McGraw Hill Publications)
4. Grabal Arvin, "Microelectronics", (Tata McGraw Hill Publications)
5. Gaikwad Ramakant, "Operational Amplifier" (Prentice Hall of India Pubs)
6. Malvino Lench, "Digital Electronics", (Tata McGraw Hill Publications)

Course Outcomes:

A. Learner will able to apply his knowledge of science and engineering.
B. Learners will get enough knowledge and understanding of the devices which can be used in various applications.
C. Graduates would also capable to identify various amplifier circuits and able to solve problems theoretically and practically.
D. Students will understand impact of electronic circuits in various electrical / electronic appliances used in day to day life.
E. Learner will able to formulate simple circuits for small applications in practice.

H. The knowledge gained related to basic electronic circuits will help students to get job in companies.

Table 9 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√			√							
2	√	√									
3	√		√	√				√			
4					√			√			
5					√			√			

(EE 405) ELECTIVE – I (INTRODUCTION TO NON CONVENTIONAL SOURCES OF ENERGY)

Unit 1 Energy scenario in India Sources of energy systems, fossil and renewable. Impact of fossil fuel based systems. Renewable energy sources and features.

Unit 2 Solar Thermal Systems: introduction to Solar thermal systems. Energy conversion principle and applications; solar water heaters, space cooling, solar distillation. Solar cooking, solar green house, solar production of hydrogen, simple illustrative numerical.

Unit 3 Solar Photovoltaic System: Operating principle concept of P V cell, module, array and array combination. Applications; battery charging, pumping, lighting. Simple illustrative numerical.

Unit 4 Wind Energy System: Principle of wind energy conversion. Basic components of wind energy conversion system, classification of wind energy conversion system and design concepts. Extraction of power Simple illustrative numerical.

Unit 5 Energy Storage Systems: Mechanical energy storage, electrical storage, chemical storage, electromagnetic energy storage, thermal energy storage, biological storage.

Unit 6 Energy conservation: Economic concept of energy, principle of energy conservation energy conservation technology, energy audit and co-generation.

References

1. G D Rai. ” Non Conventional Sources of Energy”.(Khanna publications)
2. H P Garg and Jai praksh “ Solar Energy Fundamentals and applications”,(Tata McGraw Hill Publications)
3. D Mukharjee and S Chakrabarti “ Fandamentals of Renewable Energy Systems” (New Age International Publication)
4. L Umanand “Non Conventional Energy System” Web Cource NPTEL Course No 22 Electrical Engineering. Email: ums@cedt.iisc.ernet.in

(EE 405) ELECTIVE – I (POWER PLANT ENGINEERING)

Unit 1 Load and Energy survey, load duration curve, plant factor and plant economics, Introduction to conventional energy sources, different sources of non-conventional energy like solar, wind, tidal, geothermal biomass, MHD plants, their applications and site selection, Indian energy scenario.

Unit 2 THERMAL ENERGY SYSTEMS:

Thermal Power Station: Introduction, selection of sites, main parts of thermal power station and their working, simple numerical examples.

Nuclear Power Plant: Review of atomic physics (atomic number, mass number, isotopes, atomic mass, unit rate of radioactivity, mass equivalent number, binding energy and mass defects), main parts of nuclear power station, types of reactors (pressurized water reactor (PWR), boiling water reactor, gas cooled reactor, liquid metal tank feeder reactor, heavy water reactor, plant layout and working, simple numerical, India's nuclear power program.

Unit 3 Hydroelectric Power Plant: Advantages and limitations, selection of site, hydrological cycles and hydrographs, storage and pondage, essential elements of hydroelectric plant, classification, different types of turbines and their selection, governing of hydraulic turbines, surge tanks, draft tube, layout of hydro-station, simple numerical.

Unit 4 Diesel Engine & Gas Power Plant: Advantage and limitations, types of diesel plants, general layout, IC engines and their performance characteristics, layout of diesel engine power plant and applications. Components of gas power plant, gas turbine fuels, turbine fuels, turbine materials, working, improvement of thermal efficiency of gas power plant and applications, simple numerical examples.

Unit 5 Combined working of power plants: Economics of combined working power plants, base load and peak load stations, pumped storage plants, inter- connections of power stations. Tariff: Fixed cost, running cost and their interrelation for all types of conventional power plants, depreciable cost, different types of tariffs, numerical example based on above, effect of deregulation on pricing.

Unit 6 Grid interface of different power plants: Concept of parallel operation of various generating sources and load sharing, need of interconnection between different power plants, concept of Grid, importance of grid, requirement of grid, types of grid (in transmission and distribution system), conditions to interface different power plants to grid.

References

1. Gupta B. R. " Power Plant Engineering".(Eurasia publications)
2. Nag P. K. " Power Plant Engineering",(Tata McGraw Hill Publications)
3. Deshpande M. V. " Elements of Electrical Power Station Design" (Wheeler publications)
4. Arora and Domkundwar, "A course in Power Plant Engineering" (Dhanpat Rai & co., 5/e)
5. R. K. Rajput, "Power Plant Engineering"
6. V. K. Mehta, "Power System", S. Chand Pub.
7. J. B. Gupta, "A course in Power System Engineering",

SEMESTER – V

Subject : EE501 – AC Synchronous Machines

Course Objectives:

1. Learner can able to apply his fundamental knowledge gained related to electrical machines for advanced machines (synchronous machines) and their performance evaluation.
2. Understand control techniques of synchronous machines, commutator machines.
3. Application areas of these machines in various fields.

(EE 501) ALTERNATING CURRENT SYNCHRONOUS MACHINES

Unit 1 Synchronous Generator: Basic principle, Stationary armature and rotating field system, details of construction, rotor, damper winding, excitation system, Three phase armature winding, induced e.m.f., behaviour of alternator on load, armature reaction on unity, lagging and leading power factor Leakage reactance, Synchronous reactance and impedance, Phasor diagram of alternator on load with unity lagging and leading power factor

Unit 2 Voltage regulation: Methods of determining voltage regulation by direct Method, synchronous impedance method, ampere-turn method and zero Power factor method / Potier triangle method.

Unit 3 Parallel operation: Necessary conditions, Synchronizing methods, concept of Synchronizing torque, Effect of load on Synchronizing power, effect of change in excitation and change in prime mover input on load sharing, Numerical examples.

Unit 4 Synchronous Motor: Principle of operation, method of starting, Power flow, Effect of constant excitation, Effect of change in excitation at constant load, various torques (starting, running, pull in & pull out torque), Effect of excitation on armature current and on power factor (inverted V Curves), Equation for power developed and torque developed Comparison between synchronous and Induction motors, Hunting, Applications, Numerical examples.

Unit 5 A.C. Commutator Motor: Generation of e.m.f. in different windings, Transformer and rotational e.m.f. in phase winding, rotational e.m.f. due to stationary, rotating and alternating fluxes, Numerical examples.

Unit 6 Schrage Motor: Principle of operation, Primary winding, regulating winding, secondary winding, principle of working, starting, speed control, power factor improvement.

References

1. Clayton E. W. – Performance & Design of Commutator machine.
2. Say M. G. – Performance & Design of Alternating Current Machine.(English Language Book Society).
3. Ashfaq Hussein – Electrical Machines.
4. Bhimra P. S. – Electrical Machines.(South Ex Publication).
5. Nagarath & Kothari – Electrical Machines (Tata McGraw Hill).
6. Tailor O. E. – AC Commutator Machine (English Language Book Society).

Course Outcomes:

A. Students will able to use the knowledge of mathematics and engineering.
C. Understand functioning of specialized machines and their control techniques.
E. Understand the field / industrial applications of these machines.
I. Develop an ability to learn modern techniques, and tools in practice.
K. Develop an ability to use modern techniques, skills in practice.

Table 10 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	B	C	D	E	F	G	H	I	J	K
1	√		√						√		
2					√						√
3					√						√

Subject : EE502 – Power System Operation and Control

Course Objectives:

1. To prepare students for Basic understanding of the conceptual and practical approach of electrical power system operation and its control methodology.
2. To understand different techniques of calculation of power flow and control of different electrical parameter.
3. To understand the real life approach and practical aspects of the electrical power system.
4. To get familiar with the mathematical treatment and methods of calculation used for power system control and analysis.

(EE 502) POWER SYSTEM OPERATION AND CONTROL

Unit 1 Economic Operation of Power Systems: Distribution of loads between units within a plant, Economic division of load between units in a plant, Transmission loss as a function of plant generation, Calculation of loss co-efficient, Distribution of load between plants, Introduction to unit commitment, Numerical examples.

Unit 2 Load Flow Studies: Network model formulation, (Applications of iterative techniques like Gauss-Siedal method, and Newton-Raphson method, etc) Numericals. Active Power Control Basic generator control, Load frequency control. Load, prime mover and governor model, Numerical examples.

Unit 3 Reactive Power Control: System voltage and reactive power, Reactive power generation by synchronous machine, Excitation control, Automatic voltage regulator for alternator, Reactive power generation by turbo-generator, Synchronous compensators, Reactors, Capacitors, Static compensators. Introduction to power flow control, HVDC and Facts.

Unit 4 Symmetrical and unsymmetrical fault analysis: Symmetrical Components transformation analysis for, transformers, transmission lines and synchronous machines, Numerical examples. Fault analysis and evaluation of faults on loaded unloaded synchronous generator, Selection of circuit breakers, asymmetrical fault- evaluation of a) Line to ground b) Line to line c) Double line to ground d) single & double conductor open faults, Numerical examples.

Unit 5 Stability: Dynamics of a synchronous machine, Power angle equation, Steady state stability, Equal area criterion, Numerical solution of swing equation, Factors affecting transient stability, Critical clearance angle, Numericals.

Unit 6 Load dispatch centre functions, Contingency analysis, preventive, emergency and restorative Control.

References

1. Stevension .W. D– Power System Analysis. (Tata Mcgraw Hill).
2. Ashfaq Hussian - Power System Analysis. (Tata Mcgraw Hill).
3. Nagrath & Kothari – Modern Power System Analysis.(Tata Mcgraw Hill).
4. Hadi Sadat – Power System Analysis (Tata Mcgraw Hill).
5. Prof A M Kulkarni IIT, Bombay – Web Course on Power System Operation and Control (NPTEL)

Course Outcomes:

A. Students will able to mathematical tools to solve power system engineering problems.
B. Student will capable to know thoroughly the concepts of power system operation and control.
E. Students will learn complex mathematical solution techniques.
H. The demand power industries will be served to large extents.
I. Learners' skill will be improved by use of software program like MATLAB, Mipower, etc.
K. Students can find the roots of their future career.

Table 11 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√				√						√
2		√							√		
3	√							√			
4		√			√					√	√

Subject : EE503 – Microprocessors Microcontrollers

Course Objectives:

1. After learning Microprocessors and Microcontrollers course, students will get introduced with the importance of electronics control and its applications in industries.
2. Introduced with embedded systems and its applications for various controls in electrical engineering.
3. The learner can design microprocessor based systems and thus can become successful entrepreneur and meet needs of Indian and multinational industries.
4. The students will get acquainted with recent trends in microcontroller like pipelining, cache memory etc.

(EE 503) MICROPROCESSORS AND MICROCONTROLLERS

Unit 1 **Architecture of 8085 Microprocessor and Programming:** Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals, Machine cycles and timing diagrams.
Instruction formats, Addressing modes, Instruction set, Need for Assembly language, Development of Assembly language programmes.

Unit 2 **Interfacing:**
Memory Interfacing: Interface requirements, Address space partitioning, Buffering of Buses, timing constraints, Memory control signals, Read and write cycles, interfacing SRAM, EPROM and DRAM sections.
I/O Interfacing: Memory mapped I/O Scheme, I/O mapped I/O scheme, Input and Output cycles, Simple I/O ports, Programmable peripheral interface (8255). Data transfer schemes: Programmable data transfer, DMA data transfer, Synchronous, Asynchronous and interrupt driven data transfer schemes, Interfacing, Simple keyboards and LED displays.

Unit 3 **Interrupts and DMA:** Interrupt feature, Need for interrupts, Characteristics of Interrupts, Types of Interrupts, Interrupt structure, Methods of servicing interrupts, Development of Interrupt service subroutines, Multiple interrupt request and their handling, need for direct memory access, Devices for Handling DMA, Programmable DMA controller 8237.

Unit 4 **Applications:** Interfacing of A/D converters (ADC 0800/ADC 0808/ADC 0809), Interfacing of D/A converters (DAC 0800), Waveform generators, Multiplexed seven segment LED display systems, Measurement of frequency, phase angle and power factor- Traffic light controller, Stepper motor control

Unit 5 **Intel 8051 Microcontroller :** Architecture of 8051, Memory Organization, Addressing modes, Instruction set, Boolean processing, Simple programmes.

Unit 6 **8051 Peripheral Functions :** 8051 interrupt structures, Timer and serial functions, parallel port features : Modes of operation, Power control, features, Interfacing of 8051, Typical applications, MCS 51 family features

References

1. Goankar, R.S., "Microprocessor Architecture Programming and Applications with the 8085/8080A, 3rd Edition, Penram International Publishing House, 1997.
2. Singh I.P., "Microprocessor Systems", Module 9 : Microcontrollers and their Applications", IMPACT Learning Material Series IIT, New Delhi, 1997.
3. Douglas V. Hall., "Microprocessor and Interfacing Programming and Hardware", 2ndEdition, McGraw Hill Inc., 1992.
4. Kenneth, L. Short, "Microprocessors and Programmed Logic", Prentice Hall of India, 2nd Edition, 1987.

Course Outcomes:

A. Learner gains ability to apply knowledge of engineering in designing different case studies.
B. Graduates will be able to design real time controllers using microcontroller based system.
C. Students get ability to interface electromechanical system to function in multidisciplinary system like in power plant engineering, robotics, automobiles etc.
D. Students will able to work in multidisciplinary team.
E. Students can identify and formulate control and monitoring systems using microcontrollers.
H. Students will design cost effective real time system to serve engineering solution for global, social and economic context.
K. This course understanding will enforce students to acquire knowledge of recent trends like superscalar and pipelining and thus finds recognition of continuous updation.

Table 12 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√		√		√						√
2	√	√	√		√			√			
3		√		√	√			√			√
4		√	√								√

Subject : EE504 – Electrical Installation and Estimation

Course Objectives:

1. Learners will able to understand design of transmission, distribution lines and their estimates.
2. Learner will able to understand the process of selecting material, equipments for various measurements, protection and other applications in power network.
3. Learner will be introduced with tendering, various purchase procedures, their advantages and limitations.
4. Will learn about different types of wirings, control panels, tools required and precautionary measure.

(EE 504) ELECTRICAL INSTALLATION AND ESTIMATION

Unit 1 Estimating and Determination of conductor size for internal wiring, HT and LT Overhead Lines and Underground Cables: Various steps to form an estimate, Price catalogue, Schedule of labour rates, Schedule of rates and estimating data, Conductor size, calculations for internal domestic wiring, Permissible voltage drops for lighting and industrial load, simple numericals, Conductor size calculation for underground cables: General considerations, Simple numericals, Conductor size calculations for overhead lines with A.C.S.R. conductors, simple numericals.

Unit 2 Preparation of estimate of quantity of material required for wiring of a house (typical plan of house including electric layout is to be given). Drawing of electrical circuit for such electrification. Specification for accessories like AC energy meter, main switch, Tumbler switch, Electric heater, Fluorescent tube, Chokes for tubes, starters, bulbs, and Insulation tapes.

Unit 3 Principles of Contracting: Purchasing techniques, Spot quotations, Floating limited enquiry, Typical example of quotation form, preparation of comparative statement, Analysis of comparative statement, Tenders types (Single tender, Open tender), Earnest money, Security deposit, Various steps involved in complete purchase, Typical order formats, various criteria for selecting the supplier, General considerations in order form, Procedures to be followed for submitting the tenders & quotations.

Purchase Department, Objective, activities, duties and functions, purchase organization, Centralized and decentralized purchasing, relative advantages and disadvantages, Applications.

Unit 4 Study of different types of components in electrical distribution system:

Cables: Classification, general construction, types of cables, jointing of cables, measurement of insulation resistance, Insulators: Requirements, materials used, types (Pin, Suspension, Strain, Stay) Substation: Different types, classification, design consideration, various symbols, complete arrangement of substation (Single and double bus bar), key diagrams for typical substations.

Review of Insulated Wires: Types: Rubber covered taped and compounded or VIR, Lead alloy sheathed, Tough rubber sheathed, Weather proof, Flexible wire splicing, Termination (Twist splicing, Married joint, Tap joint, Pig tail joint) Different Types of Switches: Tumbler, flush, pull, grid, architrave, rotary snap, Push button, Iron clad water proof, Quick break knife switch. Ceiling roses, Mounting blocks, Socket outlets plugs, Main switches, Distribution fuse boards, MCB (Miniature Circuit Breakers).

Unit 5 Different Tools Used: Screwdriver, Pliers of various types, wrench, and blowlamp, Precaution for using tools.

Unit 6 Wiring System: Selection of types of wiring. Methods of wiring (Cleat, Casing capping, Metal sheathed and Conduit) Calculation and Estimation of power rating of different AC and DC machines, schematic and wiring diagrams for motor control and protection circuit

References

1. Uppal .S. L – Electrical Wiring, Estimation & Costing (Khanna Publication).
2. Raina & Bhattacharaya – Electrical Design Estimating & Costing (Willy Eastern).

Course Outcomes:

A. Learner gains ability to apply knowledge of engineering in designing power system networks.
B. Learner will able to do experiments and analyze experimental data.
D. Graduates will be able to design real time systems and develop multidisciplinary skills.
H. Students will design cost effective real time system to serve engineering solution for global, social and economic context.
I. This course understanding will enforce students to acquire knowledge of recent trends in power system networks.

K. Students can find the roots of their future career in power system engineering and develop entrepreneurship skills.

Table 13 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√	√									√
2				√				√	√		
3									√		
4								√			√

(EE 505) ELECTIVE – II : INDUSTRIAL INSTRUMENTATION

Unit 1 Introduction: Trends in industrial process control, selection of key variables for process control, hydraulic, pneumatic and electronic instrumentation.

Unit 2 Flow Measurement: Construction, working principle, selection criteria and application of flow measurement with orifices, magnetic, ultrasonic, vortex flow meters, turbine flow meter and rotameter.

Unit 3 Level Measurement : Construction, working principle, selection criteria and application of level detectors, float level devices, level gauges, optical level devices, radiation level sensors, thermal level sensors, level switch .

Unit 4 Temp. Measurement: Construction, working principle, selection criteria and application of temp sensors – thermocouples, RTD's, thermisters, radiation pyrometry, IR detectors.

Unit 5 Pressure Measurement: Construction, Working principle, selection criteria and application of pressure sensors – bellows, tiaphragon, bourdon and helical types, electronic pressure sensor, manometers, pressure gauges, vacuum sensors, high pressure sensors, pressure switch.

Unit 6 Measure system for Density, pH, humidity, moisture and viscosity measurement

References

1. Mechanical measurements by AK Sawhney; Dhanpat Rai and Co. New Delhi
2. Process control instrumentation technology by Custis D Johnson: John Wiley and sons
3. Process/Industrial Instruments and Control Handbook by considine; Douples M: Magraw Hill
4. Mechanical Measurement by Becwith and Buch: pearson
5. Mechanical and Industrial Msrunts by RK Jain, Khanna Publisher, New Delhi

EE505 : Elective – II : Non Conventional Energy Resources (Introduction to Biomass and Geothermal Energy)

Course Objectives :

I 1 To introduce students to the concepts of energy and environmental engineering branch for successful career in the specified field.

II 2 To understand and develop the basic concept and fundamentals of Biomass and geothermal energy and their applications based on current needs.

3 To be able to differentiate between different processes of energy conversion systems, their characteristics and utility for the sources as above.

4 To be able to know the concept of hybrid power plants based the sources and

III identify important parts of the plants.

5 To understand concepts and impact of climate pollutions, types causes and simple

remedies.

	6	To possess knowledge of advanced and emerging topics in environment impact assessment policies and auditing,
	7	To understand concepts and impact of conflicting worldviews and environmentally
IV		sustainable economic growth, introduction to Design For Environment (DFE), product lifecycle assessment
	8	Students will understand concepts, structure, realm of ecology, and greenhouse effect
	9	Students will understand procedure-oriented and object oriented applications of biodiversity, threat and conservation of biodiversity.
V	10	To mold students professionally to possess basic and advanced knowledge by course contents along with emerging topics.

(EE 505) Elective – II : NON CONVENTIONAL ENRGY RESOURSES (INTRODUCTION TO BIOMASS AND GEOTHERMAL ENERGY)

Unit 1 Biomass Energy : Introduction, Biomass conversion technologies, Biogas generation, classification of biogas plants and their Operating system.
Biomass as a source of energy, methods of obtaining energy from biomass, thermal gasification of biomass, Applications

Unit 2 Geothermal Energy : Introduction, Geothermal sources , hydrothermal resources, Vapor dominated systems, Liquid dominated systems, hot water fields, Geo pressure resources, hot dry rocks, magma resources, volcanoes. Interconnection of geothermal fossil systems, geothermal energy conversion and applications.

Unit 3 Hybrid energy systems : Need for hybrid systems, types of hybrid systems site specific examples; PV–Diesel and battery systems, PV–Gas Hybrid system, Biomass gasifier based thermal back up for Solar systems, natural convection solar driers in combination with biomass back up heater. Biogas and solar energy hybrid system, .typical applications.

Unit 4 Air pollution-primary, secondary, chemical and photochemical reactions, effects of CO, NO, CH and particulates, acid rain, global warming and Ozone depletion; monitoring and control of pollutants; noise pollution-sources and control measures; thermal-, heavy metals- and nuclear pollutions; industrial pollution from paper, pharmacy, distillery, tannery, fertilizer, food processing and small scale industries.

Unit 5 Environment impact assessment policies and auditing, conflicting worldviews and environmentally sustainable economic growth, introduction to Design For Environment (DFE), product lifecycle assessment for environment and ISO 14000; triple bottom line of economic, environment and social performance.

Unit 6 Ecosystem definition, concepts, structure, realm of ecology, lithosphere, hydrosphere, biosphere, atmosphere-troposphere-stratosphere; Nonrandom high quality solar energy flow/ balance to earth, greenhouse effect, matter and nutrient recycling in ecosystems; nitrogen, oxygen, carbon and water cycles, food producers, consumers and decomposers, food chains; biodiversity, threat and conservation of biodiversity.

References NPTEL courses

Course Outcomes :

A. Learner will be able to understand significance of energy and environmental engineering based on current needs.

B. Develop an ability to compare different energy sources and their application to electrical components and make analyses of the same as per the requirement of the problem.

C. An ability to design a system, a component to meet desired needs and will be able to compare different options for hybrid operation, analyze and interpret results for different application to meet desired needs within realistic constraints.

D. The learner will develop an ability to function on multidisciplinary teams related to energy and environment studies.

E. Students will build an ability to identify, formulate and solve simple energy and environment related engineering problems..

G. With the basic knowledge of the energy sources and power plants students will be able to develop interest for the national program on energy and environment.

H. The Students will understand broad education necessary to understand the impact of conflicting worldviews and environmentally sustainable economic growth, in a global and economical context.

J. The technical skills in the field of energy and environment will provide a recognition and need for an ability to engage in life-long learning

K. Student will possess ability to use the techniques, skills, and modern engineering tools necessary for electrical engineering practice.

Table 14 : Mapping of course objectives with course outcome

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
I	√	√			√				√		√
II	√						√	√	√		√
III		√		√	√			√	√		√
IV	√		√	√	√		√		√		√
V			√	√	√			√	√		√

(EE 505) Elective – II : BIOMEDICAL INSTRUMENATION

Unit 1 Anatomy and Physiology : Elementary ideas of cell structure, heart and circulatory system, control nervous system, Musclo-skeletal system, Respiratory system Body temperature and reproduction system. Classification of Biomedical Equipment, Diagnostic, therapeutic and clinical laboratory equipment

Unit 2 Bioelectric signals and their recording : Bioelectric signals (ECG, EMG, ECG, EOG & ERG) and their characteristics, Bioelectrodes, electrodes tissue interface, contact impedance, effects of high contact impedance, types of electrodes, electrodes for ECG, EEG and EMG.

Unit 3 Transducers for Biomedical Application :
Resistive transducers - Muscle force and Stress (Strain guge), Spirometry (Potentiont), humidity, (Gamstrers), Respiration (Thermistor)
Inductive Transducers - Flow measurements, muscle movement (LVDT)
Capacitive Transducers - Heart sound measurement,
Pulse pick up Photoelectric Transducers - Pulse transducers, Blood pressure, oxygen Analyses
Piezoelectric Transducers - Pulse pickup, ultrasonic blood flowmeter
Chemcial Transducer - Ag-Agfallas (Electrodes, PH electrode

Unit 4	Bioldectric Signal recording machines : Physiological pre-amplifier and specialized amplifiers, ECG lead systems details of ECG, EMG, and EEG machines, Patient Monitoring system, Heart rate measurement pulse rate measurement, respiration, rate measurement, blood pressure measurement, microprocessor applications in patient monitoring, X- Ray Machine
Unit 5	Basic X-Ray components and circuits, types of X-ray machines e.g. general purpose, dental image intensifier system, table shooting and maintenance of X- Ray machine
Unit 6	Safety Aspect of Medical : Gross current, Micro Current shock, safety standards rays and considerations, safety testing instruments, biological effects of X-rays and precautions
References	NPTEL courses

SEMESTER – VI

Subject : EE601 – Switchgear and Protection

Course Objectives:

1. Learners should able to use mathematical tools and engineering knowledge to formulate problems.
2. Students will be able to understand importance and need of protection in power system networks.
3. Learner should able to use protective scheme for various equipments in power system network.
4. Learner will understand importance and types of earthing, insulation needs and coordination.

(EE 601) SWITCHGEAR AND PROTECTION

Unit 1 Switchgear and protection: Different types of switchgear, modes of classification, ratings and specifications.
Protective Relaying: Need of protective relaying in power system, General idea about protective zone, Primary and backup protection, Desirable qualities of protective relaying, Classification of relays, Principle of working and characteristics of attracted armature, balanced beam, induction, disc and cup type relays, induction relays, Setting characteristics of over current; directional, differential, percentage differential and distance (impedance, reactance, mho) relays, introduction to static relays, advantages & disadvantages.

Unit 2 circuit interruption: Principles of circuit interruption, arc phenomenon, A.C. and D. C. circuit breaker, Restricting and recovery voltage. Arc quenching methods. Capacitive, inductive current breaking, resistance switching, Auto reclosing.

Unit 3 Circuit Breakers: Construction, working and application of Air blast, Bulk oil, Minimum oil, SF_6 and vacuum circuit breakers, Circuit breaker ratings, Rewirable and H. R. C. fuses, their characteristics and applications.

Unit 4 Bus bar: Feeder and Transmission line protection. Bus bar protection, Frame leakage protection circulating current protection and Transmission line protection using over current relays. Principles of distance relaying, choice between impedance, reactance and mho types, pilot wire and carrier pilot protection.

Unit 5 Protection of Alternators and Transformers:
Alternators – Stator fault, stator inter turn protection. Unbalanced load, protection (Negative phase sequence [NPS] protection)
Transformer – Use of Buccholz relay, differential protection, connection of C. T. and calculation of C.T. ratio needed for differential relaying, balanced and unbalanced restricted earth fault protection, frame leakage protection.
Generator-Transformer unit protection

Unit 6 Insulation co-ordination and over current protection:
Definitions (Dry flashover voltage FOV), WEF FOV, Impulse FOV, insulation, co-ordinating insulation and protective devices. Basic impulse insulation (BIL), Determination of line insulation. Insulation levels of substation equipment. Lightning arrester selection and location. Modern surge diverters and Necessity of power system earthing, Method of earthing the neutral, Peterson coil, earthing of transformer.

References

1. Patara Basu & Chaudhary – Power System Protection.(New Delhi Oxford And IBH).
2. Sunil S. Rao – Switchgear & Protection.(Tata Mcgraw Hill).
3. Madhavrao .T. S– Static relay.

Course Outcomes:

A. Students will able to use mathematical tools and engineering knowledge to study the importance of protection needs.
C. Students will able to design protection controls as per requirement.
G. Students will understand their responsibility in designing protective schemes.

H. Learner will able to design and use protection equipments economically and understand its impact on environment.
K. Students will have an ability to use technical skills, and modern engineering tools necessary for engineering practice.

Table 15 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√		√			√		√			√
2			√			√					
3						√		√			√
4			√					√			√

Subject : EE 602 - Power Electronics

Course Objectives :

I. 1 To mold students to get admission for higher study or employment in core electronics industry.
II. 1 Learn theory and operation and switching characteristics of power semiconductor devices, uncontrolled/controlled rectifiers
2 To understand fast switching semiconductor devices with their construction, working, characteristics and there fast control facility.
3 To describe the need and function of different types of converter and there control techniques.
V. 1 Learn the basic concepts of operation of dc-dc converters, ac voltage controllers, dc-dc converters (choppers), power electronic applications in motor drives and electric power systems.
2 Explain power electronic applications in power systems and motor drives, and evaluate suitable converter types of a given application.

(EE 602) POWER ELECTRONICS

Unit 1 Power semiconductor devices & their characteristics : Characteristics and operation of power diodes, thyristors, power transistors (BJTs, MOSFETs, IGBTs, SITs), Ratings of power semiconductor devices, typical applications of power semiconductor devices, Introduction to types of power electronic circuits: diode rectifiers, AC-DC converters, AC-AC converters, DC-DC converters, DC-AC converters

Unit 2 Turn on and Turn off circuits for power semiconductor devices; BJT base drive requirements and drive circuit, MOSFET & IGBT gate drive circuits, isolation of gate/base drives: Pulse transformers, optocouplers, thyristor firing schemes, gate drive ICs

Unit 3 Diode Rectifiers and AC-DC converters :
Diode Rectifiers: Single phase half wave, full wave rectifiers with R and RL load, Three phase bridge rectifier with R and RL load, Effect of source inductance
Controlled Rectifiers : Principle of phase controlled rectification, single phase semi and full converter with R and RL load, power factor improvement in controlled rectifiers, three phase semi and full converter with R and RL load

Unit 4 AC voltage controllers (AC-AC converters) : Principle of on-off control, principle of phase control in single phase and three phase circuits, Cycloconverters: single phase cycloconverters & operation, three phase cycloconverters & operation

Unit 5 DC-DC converters : Classification of DC-DC converters, Buck converter, Boost converter, Buck-Boost converter, Cuk converter

Unit 6 DC-AC converters : Principle of operation and performance parameters, single phase bridge inverter, Three phase inverters: 180 degree and 120 degree conduction modes of operation

References

1. Rashid M. H – Power Electronics circuits, devices and applications, (Pearson Education, N. Delhi).
2. Murthi V. R-Power Electronics Devices, Circuits and Industrial Applications. (Oxford).
3. Bimbhra P. S - Power Electronics. (Khanna Publication).

Course Outcomes :

A. Learner will apply knowledge of mathematics to solve numerical based on converters to find output power.

B. Students will able to design a circuitry Power Converter, Commutation and speed control of AC and DC motors. Students will understand speed control of AC and DC motors.

D. Students will able to apply knowledge to solve problems on analysis of multidisciplinary teams.

E. Student will be able to formulate and solve numerical by understanding converter and commutation specifications.

J. Student will be able to understand the concept of inverters, single and three-phase cyclo-converters, AC voltage regulators

K. Describe the characteristics of power semiconductor devices and identify suitable switch choices for a given application.

Table 16 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
I	√	√		√	√						√
II	√			√	√					√	√
V	√	√		√	√					√	√

Subject : EE603 – Principles of Electrical Machine Design

Course Objectives :

I	1	To prepare students for successful career in industries, for Post Graduate programmes and to work in research institutes.
II	2	To understand and develop the concept of designing of various electrical machines.
	3	To be able to differentiate between electrical and magnetic circuits and their loading concepts.
	4	To be able to develop conceptual designs and identify different materials for the important parts of machines.
	5	To be able to verify the designs and confirm dimensions.
III	6	An ability to design and draw a system, or a component, to meet desired needs within realistic constraints
	7	To possess knowledge of advanced and emerging topics in special control machines and their applications in the field of control Engineering.
IV	8	An ability to design a system, a component, to meet desired needs within realistic constraints and confirms manufacturability, and sustainability.
V	9	To mold students professionally to possess in-depth and advanced knowledge by course contents along with emerging topics.

(EE 603) PRINCIPLES OF ELECTRICAL MACHINE DESIGN

Unit 1 Principles and design of Electrical machines: Design of Electrical machines along with their parts and special features, rating, Specifications, Standards, Performance and other criteria to be considered, Brief study of magnetic, electric, dielectric and other materials, Introduction to machine design.

Unit 2 Design of Electrical Apparatus: Detailed design of heating coils, starters and regulators. Design of Electrical Devices Field coils, Chokes and lifting magnets.

Unit 3 AC and DC Winding: Types of dc windings, Pitches, Choice and design of simple/ duplex lap and wave winding, Concept of multiplex windings and reasons for choosing them, Single and double layer single phase AC winding with integral and fractional slots, Single and double layer integral and fractional slot windings of three phase. AC winding factors, Tests for fault finding in windings, Numerical examples.

Unit 4 Heating, Cooling and Ventilation: Study of different modes of heat generation, Temperature rise and heat dissipation, Heating and Cooling cycles, heating and cooling time constants, their estimation, dependence and applications, Methods of cooling / ventilation of electrical apparatus, Thermal resistance, radiated heat quantity of cooling medium (Coolant) Numerical.

Unit 5 Design of Transformer: Design of distribution and power transformers, Types, Classification and specifications, Design and main dimensions of core, yoke, winding, tank (with or without cooling tubes) and cooling tubes, Estimation of leakage reactance, resistance of winding, No load current, Losses, Voltage regulation and efficiency, Mechanical force developed during short circuits, Their estimation and measures to counteract them, Testing of transformers as per I.S.S., Numerical examples.

Unit 6 Computer aided Design of Electrical machine: Introduction, advantages various approaches of Computer Aided Designing, Computer Aided Designing of transformer, Winding of rotating Electrical Machines. Optimization of Design.

References

1. Siskind – Electrical Machine Design(Mcgraw Hill).
2. Sawhaney. A. K– A Course in Electrical Machine Design(Dhanpat Rai).
3. Deshpande. M. V- A Course in Electrical Machine Design(Prentice Hall Of India).(Design And Testing Of Electrical Machines).
4. Sen .S. K– Computer aided design of Electrical Machines

Course Outcomes :

A. Learner will be able to understand significance of electrical machine design and components.

B. Develop an ability to compare electrical and magnetic circuits for different types of drives, and equipments and also will be able to choose proper materials as per the requirement of the problem.

C. An ability to design a system, a component to meet desired needs, differentiate and will be able to compare different options based on results, and able to analyze and interpret results for different industrial application to meet desired needs within realistic constraints and confirms manufacturability

E. Students will build an ability to identify, formulate and solve industrial problems related to machine and equipment design problems.

G. With the basic knowledge of the machines, equipments design and course, students will be able to develop computer programs for the utility and machine design techniques.

H. The Students will understand broad education necessary to understand the impact of electrical machine design solutions in a global and economical context.

I. Students will understand procedure-oriented and object oriented applications of electrical machine design concepts.

K. Student will possess ability to use the techniques, skills, and modern engineering tools necessary for electrical machine utility practice.

Table 17 : Mapping of course objectives with course outcome

Course Objectives	Course Outcomes										
	A	B	C	D	E	F	G	H	I	J	K
I	√	√			√				√		√
II	√						√	√	√		√
III		√			√			√	√		√
IV					√		√		√		√
V			√		√				√		√

Subject : EE604 – Control Systems – I

Course Objectives:

1. To make the students aware of the basics of control system, it's classification and its use in various fields of engineering to develop real time applications to meet the needs of multinational industries.
2. To make the learner understand the basic theory of Laplace Transform, Transfer Function, Impulse response and mathematical modeling for the overall analysis of the control system.
3. Make aware the students with control system components, their modeling and applications in electrical engineering.
4. To introduce students to the basic concepts of time domain and frequency domain stability analysis &design using various design methods like Root locus, Nyquist plots, Bode plots etc.

(EE 604) CONTROL SYSTEMS – I

Unit 1 Introduction: Concept of open & closed loop control system, Servomechanism, Multivariable control system, Applications in non-engineering field.

Unit 2 Physical Systems and Transfer Function:

a) Concept of system: physical system, Physical model, Linear and nonlinear systems, Time variant and invariant system.

b) Equations of physical systems (Mass-Spring-Dashpot system, R-L-C series & parallel circuit) transfer function, Procedure of obtaining transfer function.

Unit 3 Block diagrams and Signal flow graphs:

a) Block diagram algebra, Diagram reduction, Numerical examples.

b) Signal flow graph; Masons gain formula for deriving overall transfer function of systems. Feedback characteristics of control system: Concept of negative and positive feedback, Sensitivity of the system to parameter variation, using negative and positive feedback.

Unit 4 Control system components: Derivation of transfer functions of following components **(a)** DC servomotors (Armature and field control) **(b)** AC servomotors **(c)** Amplidyne generators **(d)** Synchros **(e)** DC and AC tachogenerators **(f)** Potentiometer error detectors.

Unit 5 Time domain analysis: Typical test signals, Time domain specifications, Steady state response, Types of system, Steady state error constants and steady state error, (With different input), Numerical examples, transient response, Numericals, Concept of stability, Determination of stability by Routh - Hurwitz criterion.

Unit 6 Frequency domain analysis: Introduction to frequency response, Advantages of frequency domain analysis, Polar plots, Numericals, Bode plots, Principle of argument, Nyquist criterion, Relative stability from Nyquist criterion, Numericals. Definition of Root Locus, Construction of root locus, Stability from root locus plots, Root counters, Effect of addition of poles & zeros on root locus plots.

References

1. Ogata – Modern Control Engineering (Prentice Hall Of India).
2. Kuo .B. C– Automatic Control System.(Prentice Hall Of India).
3. Nagarath & Gopal – Control System(Willey Earstern)
4. Gopal .M.– Control System.(Prentice Hall Of India).

Course Outcomes:

A. Students can apply mathematical tools to solve engineering problems.
B. Student will gain an ability to do mathematical modeling and find the transfer function of any system using various techniques such as block diagram reduction, signal flow graph etc.
D. Learner can do the complete analysis of any type (viz. mechanical, electrical electromechanical, electronics etc.) of control system with respect to system stability in time domain as well as frequency domain.
H. Student will be able to analyze whether the system is stable or not using various methods like Routh Hurwitz criterion, Root Locus, Bode plot, Nyquist plot.
J. Student will get familiar with advanced applications of control system.
K. Overall ability to use different techniques, skills, and modern engineering tools necessary for engineering practice.

Table 18 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√			√				√		√	
2	√	√									
3	√			√							
4		√									√

Subject : EE605 - Elective – III : Industrial Automation and Control

Course Objectives :

I 1 To introduce students to the concepts of structure of industrial automation and control.
II 2 To understand and develop the basic concept and fundamentals of measurement and sensor systems and their applications for different engineering applications.
3 To be able to differentiate between different industrial processes and their characteristics for the control and automation purpose.
4 Student will be able to know the concept of special control structures and identifies important
III parts of the system.
5 To understand concepts and impact of automation types based on the needs.
6 To possess knowledge of advanced and emerging topics in control system and impact assessment.

IV	7	To understand concepts and impact of control loops in Designing an automation system for a process.
	8	Students will understand concepts, structure, and implementation of advanced tools like PLC and SCADA systems.
	9	Students will understand procedure-oriented and oriented applications of industrial automation and control mechanism.
V	10	To mold students professionally to possess basic and advanced knowledge by course contents along with emerging topics.

(EE 605) ELECTIVE – III : INDUSTRIAL AUTOMATION AND CONTROL

Unit 1 Introduction to Industrial Automation and Control: Architecture of Industrial Automation Systems. Introduction to sensors and measurement systems.

Unit 2 measurement: Temperature measurement, Pressure and Force measurements, Displacement and speed measurement, Flow measurement techniques, Measurement of level, humidity, pH etc, Signal Conditioning and Processing, Estimation of errors and Calibration

Unit 3 Process Control: Introduction to Process Control P I D Control, Controller Tuning. Implementation of PID Controllers.
Special Control Structures: Feed forward and Ratio Control. Predictive Control, Control of Systems with Inverse Response, Cascade Control, Overriding Control, Selective Control, Split Range Control

Unit 4 Sequence Control: Introduction to Sequence Control PLCs and Relay Ladder Logic Sequence Control, Scan Cycle, RLL Syntax Sequence Control, Structured Design Approach Sequence Control, Advanced RLL Programming Sequence Control : The Hardware environment

Unit 5 Control of Machine tools: Introduction to CNC Machines Control of Machine Tools, Analysis of a control loop, Introduction to Actuators, Flow Control Valves. Hydraulic Actuator Systems,: Principles, Components and Symbols, Hydraulic Actuator Systems: Pumps and Motors, Proportional and Servo Valves.

Unit 6 Pneumatic Control Systems: System Components Pneumatic Control Systems, Controllers and Integrated Control Systems. Networking of Sensors, Actuators and Controllers: The Fieldbus, The Fieldbus Communication Protocol, Introduction to Production Control Systems.

References NPTEL course

Course Outcomes :

A. Learner will be able to understand significance of control and measurement techniques based on application needs.

B. Develop an ability to compare different measurement techniques, sensor systems and their application to automation and make analyses of the same as per the requirement of the problem.

C. An ability to design a system, a component to meet desired needs and will be able to compare different options for automated operation of a system, analyze and interpret results for different application to meet desired needs within realistic constraints.

D. The learner will develop an ability to function on multidisciplinary teams related to control and automation of systems.

E. Students will build an ability to identify, formulate and solve simple control and automation related engineering problems..

G. With the basic knowledge of the control and automation engineering of plants students will be able to develop interest for the national program on automation engineering and environment.

H. The Students will understand broad education necessary to understand the impact of control and automation and environmentally sustainable economic growth, in a global and economical context.

J. The technical skills in the field of control and automation environment will provide a recognition and need for an ability to engage in life-long learning

K. Student will possess ability to use the techniques, skills, and modern engineering tools necessary for electrical engineering practice.

Table 19 : Mapping of course objectives with course outcome

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
I	√	√			√				√		√
II	√						√	√	√		√
III		√		√	√			√	√		√
IV	√		√	√	√		√		√		√
V			√	√	√			√	√		√

(EE 605) ELECTIVE – III : DESIGN OF EXPERIMENTS FOR ENGINEERS AND MANAGERS

Unit 1 Introduction to experimental design principles, simple comparative experiments, introduction to R language and its applications in DOE problems.

Unit 2 Single factor experiments, randomized blocks, Latin square designs and extensions, introduction to R language Introduction to factorial designs, two levels, 2^k factorial designs, confounding and blocking in factorial designs, applications to manufacturing problems.

Unit 3 Fractional factorial designs, two-level, three-level and mixed-level factorials and fractional factorials, applications to quality control problems. Regression models including multiple regression models and its application to transportation scheduling problems.

Unit 4 Response surface methodology, parameter optimization, robust parameter design and its application to control of processes with high variability

Unit 5 Random and mixed effects models, nested and split plot and strip plot designs and its application to semiconductor manufacturing problem. Repeated measures design, analysis of covariance and its applications in comparing alternatives.

Unit 6 Design of computer experiments and the applications in industrial engineering problems.

References NPTEL Course

(EE 605) ELECTIVE – III : ARTIFICIAL NEURAL NETWORK

Unit 1	**Introduction and ANN Structure :** Biological neurons and artificial neurons. Model of an ANN. Activation functions used in ANNs. Typical classes of network architectures. **Mathematical Foundations and Learning mechanisms :** Re-visiting vector and matrix algebra. State-space concepts. Concepts of optimization. Error-correction learning. Memory-based learning. Hebbian learning. Competitive learning
Unit 2	**Single layer perceptrons :** Structure and learning of perceptrons. Pattern classifier - introduction and Bayes' classifiers. Perceptron as a pattern classifier. Perceptron convergence. Limitations of a perceptrons.
Unit 3	**Feedforward ANN :** Structures of Multi-layer feedforward networks. Back propagation algorithm. Back propagation - training and convergence. Functional approximation with back propagation. Practical and design issues of back propagation learning.
Unit 4	**Radial Basis Function Networks :** Pattern separability and interpolation. Regularization Theory.Regularization and RBF networks.RBF network design and training. Approximation properties of RBF
Unit 5	**Competitive Learning and Self organizing ANN :** General clustering procedures. Learning Vector Quantization (LVQ). Competitive learning algorithms and architectures. Self organizing feature maps. Properties of feature maps.
Unit 6	**Fuzzy Neural Networks :** Neuro-fuzzy systems. Background of fuzzy sets and logic. Design of fuzzy stems. Design of fuzzy ANNs.
References	NPTEL Course

SEMESTER VII

Subject : EE701 – Special purpose Electrical Machines

Course Objectives :

I	1	To prepare students for successful career in industries, for Post Graduate programmes and to work in research institutes.
II	2	To differentiate between generalized machines and control machines
	3	To understand principle and working of different control machines.
	4	To be able to identify and implement control machines.
	5	To be able to draw different characteristics and make their interpretations.
III	6	To possess knowledge of advanced and emerging topics in special control machines and their applications in the field of control Engineering.
IV	7	To mold students professionally to possess in-depth knowledge by course contents along with advanced and emerging topics.

(EE 701) SPECIAL PURPOSE ELECTRICAL MACHINES

Unit 1 Stepper Motor: Basic principle of working of stepper motor, Classification of stepper motor into: I) Variable reluctance stepper motor II) Single stack & multi-stack reluctance motors III) Permanent magnet & operated Stepper motor IV) Hybrid D.C. Stepper motors V) Electro hydraulic stepper motors VI) Linear stepper motors. Theory of operation of stepper motors & their characteristics, Terminology's related to stepper motors, Driving circuits & applications of stepper motors, Relative merits as a control device.

Unit 2 Hysteresis Motors: Magnetic field production & nature of torque, Applications. Reluctance Motors: F. H. P. Reluctance motors, switched reluctance motors, Principle of working & operation, Applications.

Control Motors: D C servomotors, transfer function of Armature and field controlled motors their applications, Construction of F. H. P. Induction two-phase servomotors, production of torque, Torque-speed curves-characteristics & features-dynamic equations, Methods of control, Applications. Numerical on DC and AC servos.

Unit 3 Eddy Current Devices: Construction & operation of eddy current couplings & dynamometers, merits & limitations.

Unit 4 Tacho-Generators: Basic requirements of tacho-generators, Ideal characteristics, classification. I) D.C. Tacho Generators: Output characteristics, Deviation from no-load Characteristics, Dead-zone, Tooth ripples, Temperature effect, Accuracy class. II) Induction Tacho-generators: Operating principle, Output characteristics, Equivalent circuit, Reasons for deviation from desired characteristics, Corrective means, Advantages. III) A. C. Tacho-generators: Construction & operation, Output characteristics, Non-linearities & tooth ripples, Advantages over other tacho-generators. Dynamic characteristics of tacho-generators, Applications of tacho-generators.

Unit 5 Synchro & Synchro Transformers: Different types of single phase & threephase synchros, Differential synchros, Synchro-indicators, Their constructional features, Characteristics & applications, Synchrotransformers principle, Characteristics error, applications of synchrotransformers.

Unit 6 Linear Motors: Construction, Theory of operation of a linear induction motor, System with two-dimensional & three dimensional field patterns, Performance of linear induction motors, Effect of variation in the air gap, Effect of width & thickness of the reaction plate, Thrust of linear induction motors, Applications.

References

1. Bhimbhra P. S., 'Electrical Machine and Power Electronics' Tata-McGraw Hill Publication.
2. Ogata K., 'Modem control Engineering', Prentice Hall

Course Outcomes :

A. Learner will be able to differentiate and compare different control machine used for this purpose and also will be able to choose a proper one as per the requirement of the problem.

B. Develop an ability to design and conduct experiments as well as to analyze and interpret results for different application.

E. Students will build an ability to identify, formulate and solve control engineering problems..

G. With the basic knowledge of the control machines and course, students can prepare themselves to develop computer programs for the control techniques.

H. The Students will understand broad education necessary to understand the impact of engineering solutions in a global and economical context.

I. Students will understand procedure-oriented and object oriented applications of spscial purpose machines and concepts.

K. Student will possess ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Table 20: Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	B	C	D	E	F	G	H	I	J	K
I	√	√			√				√		√
II	√						√	√	√		√
III		√			√			√	√		√
V					√		√		√		√

Subject : EE702 – Control Systems – II

Course Objectives: (CS – II)

1. To make the students aware of the advanced control system techniques for non-linear systems and its use the field of engineering to develop real time applications to meet the needs of multinational industries.
2. To make the learner analyze state variables and design models like SISO and MIMO and guide them to do the analysis on controllability and observability, state feedback controller using pole and zero placement.
3. To make students understand the architecture, programming and interfacing of various controllers like PID, their requirements in system control applications, basic related to design of PID controllers etc.
4. Make aware the student digital control system, Z-transform and stability of discrete control system.
5. To introduce student with compensation techniques and its requirement in designing using Bode plot, Root-locus techniques.

(EE 702) CONTROL SYSTEM – II

Unit 1 Non-linear Control Systems: Peculiar behavior of non-linear systems such as sub harmonics, jump resonance, limit cycle, Different types of non-linearities, Phase plane method, Singular Points, Methods of isoclines, Limit Lines & dividing lines on phase plane, Construction of phase plane, Obtaining time domain response from phase plane plots, merits & demerits.

Describing function (DF) method, definition & assumptions, Derivation for describing function for different non- linearities, Stability analysis using DF method.

Unit 2 PID controllers: Introduction to Proportional (P), Integral (I) & Derivative (D) controller, individual effect on overall system performance, P-PI & PID control and effect on overall system performance, Numerical examples

Unit 3 State Variable Technique: Concept of state & state variable, General form of state equations, formulation of state equations for the physical system, (RLC network, Armature controlled & Field controlled DC servo motor, mechanical systems).

Unit 4 State Variable Analysis: Different forms of state variable representations (Phase, physical & canonical form), Concept of diagonalization, Obtaining state equations from transfer function representation and vice versa, solution of state equations, State transition matrix (STM), Methods of finding STM, Power series method, Laplace transform method, Calay Hamilton method, Controllability & observability of linear system, Kalman's test

Unit 5 Discrete Data Control System: Methods of representation, Z-transform, Inverse Z-transforms, Pulse transfer function of closed loop system, Response between sampling instants, Concept of stability of discrete time systems, Stability by Jury's test.

Unit 6 Introduction to control system design, Compensation technique-Cascade & Feedback, Compensation network (lag, lead & lag-lead), Design by reshaping of Bode plots & Root locus technique.

References

1. Ogata K., 'Modem control Engineering', Prentice Hall
2. Kuo B. C., 'Automatic Control System' Prentice Hall
3. Nagarath I. J., Gopal M., 'Control System Engineering' Willey Eastern

Course Outcomes:

A. Students can apply mathematical tools to solve engineering problems.
B. Student will gain an ability to do mathematical modeling of non-linear systems and represent the system using advanced technique like state variable for analysis.
D. Learner can use simple techniques to represent non-linearity and analyze non-linear system for stability, controllability and observability for any type of system (viz. mechanical, electrical electromechanical, electronics etc.).
E. The learner would be able to design and analyze the systems in industrial control systems. Design PID controller for simple electrical systems.
H. Student will be able to represent and analyze discrete control systems.
I. Student will get familiar with advanced control techniques and applications of control system.
K. Overall ability to use different techniques, skills, and modern engineering tools necessary for engineering practice.

Table 21 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√							√			
2		√			√						
3	√			√					√		
4		√									√
5				√					√		

Subject : EE703 – Control Drives

Course Objectives:

1. To describe the structure of Electric Drive systems and their role in various applications.
2. Understand the basic principles of control aspects in drives using controlled converters and pulse width modulation to synthesize the voltages in dc and ac motor drives.
3. To describe the need and function of different types of converter and there control techniques.
4. To design energy efficient economic and environment friendly controllers for DC and AC drives.
5. Review the basic concepts of operation and control aspects of dc and ac motor.
6. Explain power electronic applications in motor drives, and evaluate suitable converter types for different industrial application.

(EE 703) CONTROLLED DRIVES

Unit 1 Introduction : Advantages of Electrical Drives, Parts of Electrical drive, Choice of Electric drives

Dynamics of Electrical drives: fundamental torque equations, multiquadrant operation, nature and classification of load torques, steady state stability, concept of load equalization in drives

Unit 2 Control of Electrical Drives : Modes of operation: Steady state, Acceleration, Deceleration, Drive classification.

Closed loop control of drives : Current limit control, torque control, speed control, position control, Control of multi motor drives, speed sensing, current sensing, Classes of motor duty & criteria for selection of motor

Unit 3 DC Motor Drives : Review of basic characteristics of DC motors,

Single phase drives : Single phase half wave converter drives, semi converter drives, Full converter drives, Dual converter drives.

Three phase drives : Three phase half wave drives, semi-converter drives, full converter drives, dual converter drives,

DC-DC converter drives : Principle of rheostatic and regenerative braking control, combined control, two and four quadrant DC-DC converter fed drives.

Introduction to closed loop control of DC drives.

Unit 4 Induction Motor Drives : Review of starting, braking and speed control of three phase induction motors, Stator voltage control, Rotor voltage control, frequency control, Voltage and frequency control, Current control, Closed loop control of Induction motors, Principle of Scalar and Vector control of Induction motor, Multiquadrant operation of induction motor drives fed from Voltage Source Inverters.

Static rotor resistance control method, static slip power recovery control-Static Scherbius drive and Static Kramer drive.

Unit 5 Synchronous Motor Drives : Review of starting, pull in and braking of Synchronous motor

Static variable frequency control for Synchronous motors

Load commutated inverter fed Synchronous motor drive, Introduction to closed loop control of Load commutated inverter fed Synchronous motor drive

Unit 6 Drives for Specific Applications : Textile Mill: various stages and drive requirements, control of ac motors for controlling torque.

Steel Rolling Mill : reversing and continuous hot and cold rolling mills, Drive requirements, motors for mill drive.

Cement mill : Stages in cement production, requirements of mill motors, Kiln drives, crusher drives, fan/blower drives, compressor drive.

Sugar Mill : Requirements for various drive motors, selection of motors for various processes.

References
2. Dubey G. K., "Fundamentals of Electrical Drives", Narosa Publishing house
3. De N. K., Sen P. K., "Electric Drives", Prentice Hall of India
4. Vedam Subramanyam, "Electrical Drives and Control", TMH Publications

Course Outcomes:

A. Learner will apply knowledge of mathematics to solve numerical based on dynamics of drive to study various parameters of effective control of drives and converters to find output power.
B. Students will able to design a circuitry Power Converter, Commutation and speed control of AC and DC motors. Students will understand advanced power electronics based control of AC and drives.
C. Students will able to apply knowledge to solve problems on analysis of multidisciplinary teams.
D. Student will be able to formulate and solve numerical by understanding converter and commutation specifications.
E. Student will be able to understand the concept of drive dynamics control of converters , duel converters. Single and three phase inverters and AC voltage regulators use with asynchronous and synchronous motor operation.
J. Describe the drive characteristics used in industry and of power semiconductor devices and identify suitable controller for a given application.
K. Overall ability to use different techniques, and modern engineering tools necessary electrical drives.

Table 22 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√	√	√	√	√						√
2	√	√		√	√						√
3	√	√		√	√						√
4	√	√		√	√						√
5	√	√	√	√	√					√	√
6	√	√	√	√	√					√	√

(EE 704) ELECTIVE – IV : HVDC TRANSMISSION AND FACTS

Unit 1 DC Power Transmission Fundamentals: Introduction, Economics of Dc Power transmission, comparison with AC system, Types of DC links, major components of converter station, planning of HVDC system.

Unit 2 HVDC converter: Choice of converter configuration, analysis of Gratz circuit with and without overlap, working of converter as rectifier and inverter, equivalent circuit for HVDC link.

Unit 3 HVDC System Control: Principles of DC link control, converter control characteristics, firing angle control, current and extinction angle control, Starting and stopping of HVDC link.

Unit 4 Converter Faults and Protection: Types of faults-commutation failure, Arc through, Misfire, short circuit in bridge, Over current and over voltage protection, Detection of line faults, Principle of DC circuit interruption, DC brakers, Types and characteristics of DC brakers, effects of proximity of AC and DC transmission lines.

Unit 5 FACTS Concept and General System Considerations:- Transmission Interconnections, Flow of Power in an AC System, Loading Capability limits, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic types of FACTS Controllers, Description and Definitions of FACTS Controllers, Benefits from FACTS Technology, Comparison between HVDC & FACTS.

Unit 6 Static Shunt Compensators: Objective of shunt compensation, Methods of Controllable Var Generation, Static Var Compensators: SVC and STATCOM, Comparison of SVC and STATCOM, Static Var Systems (SVS)

Static Series Compensation: Objective of series compensation, Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators

References

1. Padiyar K. R., "HVDC Power Transmission Systems", New Age international.
2. Kimbark, " HVDC Transmission", John Willey And Sons.
3. Hingorani N. G., " Understanding FACTS", IEEE Press 2001
4. Yong Hua Song, ' Flexible AC transmission systems (FACTS)'IEEE Press

(EE 704) ELECTIVE – IV : ENTREPRENUERSHIP DEVELOPMENT

Unit 1 Entrepreneurship: Aim, alternative to seeking jobs, promote self employment and accelerate industrialization, EDP in India & Maharashtra (An over view), Institutions promoting entrepreneurship, their objective and mode of functioning.

Unit 2 Motivation: Requirements and constraints: Affiliation, power achievement, goal setting, financial and carrier risks and rewards, sources of information, where to go? for what? Entrepreneurship, personality, creativity and other qualities.

Unit 3 Selecting the right Entrepreneurship field: Search, and scanning , small scale, medium scale industries, manufacturing / transporting / consultancy for selecting product for development, manufacturing.

Unit 4 Feasibility report: Market survey, right infrastructure, location and government subsidies, sources of technology, recruiting right people, identifying customers, finding out competitors, preparation of feasibility report, project report.

Unit 5 Organizational set- ups: Advantage and limitations of proprietorship, partner ship co – operatives, private limited and public limited company, management in small scale firms, entrepreneurial skills, advertising, selling and scales promotion, sale forecast.

Unit 6 Financial: Seed money, sources of finance, different financing institutions, different taxes and duties from government, certain do's and don'ts for successful entrepreneur.

References

1. A Handbook for new entrepreneurship – Entrepreneurship Development Institute of India, Ahmedabad
2. G. S. Batra, "Entrepreneurship and Small scale Industries", Deep & Deep Publications Pvt. Ltd
3. Banga, Sharma, "Industrial Organization and Management"

(EE 704) ELECTIVE – IV : ARTIFICIAL INTELLIGENCE

Unit 1 Introduction: Definition of AI, AI techniques, Tic-Tac-Toe, pattern recognition, level of the model, critiral for succen, problems and problem space, defining the problems, production systems, control strategies, Futuristic search, problem characteristic, decomposition of problems, solution steps, predictability, Absolute & relative solutions.

Unit 2 Learning: General module of learning agents, inductive learning, learning decision trees, learning general logical descriptions.

Unit 3 Fuzzy learning: Fuzzification of the system, Fuzzy logic and application to electrical problems.

Unit 4 Knowledge based learning: Knowledge in learning, explanation (Rule) based learning, Learning using relevance information, inductive logic programming, top-down learning methods, application to electrical problems.

Unit 5 Neural Networks: Working of human brain, Neural Network structure, perceptron, Neural network architecture, Back propagation learning, supervised and unsupervised learning, Bayesian methods of learning.

Unit 6 Applications: Application of Neural Network to the electrical systems.

References

1. Russell S. J., Peter Norvig P., 'Artificial Intelligencies- A modern approach'-Prentice Hall of India
2. Koske B., ' Neural Networks & Fuzzy Systems: a dynamical systems approach to machine intelligence ' Prentice Hall of India
3. Peterson D. W., 'Introduction to AI & Expert system' Prentice Hall of India

(EE 704) ELECTIVE – IV : POWER QUALITY ISSUES

Unit 1 Power Quality Issues: Definition, classification of power quality disturbances. Power quality issues, Sources of disturbance. Effect on the operation of equipments.

Unit 2 IEC & IEEE standards, guidelines and recommendations. Voltage sag, swell, interruption, transients, flickers. Guidelines & recommended practices.

Unit 3 Harmonics distortions: Harmonics in power systems, Sources, standards, effect on equipment and systems, audio and video communication systems, standards and indices.

Unit 4 Causes and conventional methods to minimize the effect of harmonics.

Unit 5 Monitoring: Fourier transforms for voltage, current and power. Measurements, Event recorders, Error measurement, power quality analysis.

Unit 6 Power Quality Mitigation: Harmonic filters, active filters, phase multiplication, power conditioners etc.

References

1. Hayatt G. T., 'Electric Power Quality' Stars in Circle Publication
2. Arrilaga J.,Watson N. R., " Power quality assessment", John Willey And Sons
3. Arrilaga J. " Power system Harmonics Analysis", John Willey And Sons
4. IEEE-519, IEC 61000, IEEE 1159 standards

Subject : EE705 – Introduction to Power System Component Modeling

Course Objectives:

1. To prepare students to study power system network and importance of modeling.
2. To understand and develop mathematical models for various components employed in electrical power system.
3. To mold students professionally to possess in-depth and advanced knowledge by course contents to attract and remain in core engineering field.

(EE 705) INTRODUCTION TO POWER SYSTEM COMPONENTS MODELING

Unit 1 Introduction to Characteristics of Power System Component : Structure of the power system, characteristics of power system components, need for modelling of power system component.

Unit 2 Transformer Modelling : Two winding, Three Winding, Phase shifting transformer modeling.

Unit 3 AC Transmission Line Modelling : Transmission Line Charatrictis, Performance Requirements, Thermal Limits, Loadability Charatrictis,

Unit 4 Synchronous machine modeling : Mathematical description of synchronous machine, equivalent circuits, stesdy state analysis.

Unit 5 Excitation system modeling : Simplified view of excitation control. Excitation configuration, primitive systems, Definitions of voltage response ratio & exciter voltage ratings.

Unit 6 Power System Load Modelling : Basic load modeling concepts, Modelling of Induction Motor.

References

1. Electric Power Systems: B.M. Weddy and B.J. Cory, John Wiely and Sons, Fourth edition (2002)
2. Power System Analysis and Design : J. Duncan Glover, Mulukutla S. Sarma,
3. Thomson Brooks/cole/ Third Edition (2003)
4. Power System Analysis and Design, B.R. Gupta, S.Chand and Company (2004)
5. Power System Stability and control, Prabha Kundur, TMH

Course Outcomes:

A. Students will able to use mathematical tools and engineering knowledge for problem formulation.
C. Learner will have an ability to analyze and design power system network to meet economical, safety and environment needs.
J. Learner will be guided to study various subjects.
K. Student will possess ability to use the techniques, skills, and modern engineering tools necessary for electrical machine utility practice

Table 23 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	B	C	D	E	F	G	H	I	J	K
1	√		√							√	√
2			√							√	√
3	√		√							√	√

SEMESTER VIII

Subject : EE801 – Electrical Utilization

Course Objectives :

I	1	To prepare students for successful career in industries, for Post Graduate programmes and to work in research institutes.
II	2	To understand and develop the concept of different drives and components employed in electrical industries.
	3	To be able to differentiate between type of drives and chose for applications depending on their loading concepts.
	4	To be able to develop conceptual designs and identify different materials for the important electrical apparatus for parts of machines.
	5	To be able to verify the designs and confirm dimensions.
III	6	An ability to design and draw a system, or a component, to meet desired needs within realistic constraints
	7	To possess knowledge of advanced and emerging topics in traction mechanism and illumination Engineering and their applications in the field.
IV	8	An ability to design a system, a component, to meet desired needs of an industry within realistic constraints and confirms manufacturability, and sustainability.
V	9	To mold students professionally to possess in-depth and advanced knowledge by course contents along with emerging topics.

(EE801) ELECTRICAL UTILIZATION

Unit 1 Industrial Utilization of Electric Motors: Review of nature of mechanical load, Matching of speed torque characteristics of load & motor, Starting condition of the load & calculation of starting time for motors, Standard loading at motors load equalization, Control devices, Pilot devices via push buttons, Limit switches, Float switches, Pressure switches, Thermostats, Plugging switches, Contactor relays & solenoid values, Simple line diagrams using above devices, Applications of electrical motors in textiles mills, Mines cranes, Lifts, Excavators, Marine drives pumps, Refrigerators & air conditioning.

Unit2 Electrolytic Processes: Faradays laws of electrolysis, Application of electrolysis, Like Electroplating, Anodizing electrical polishing & electroextraction, Accumulators & cell, Types & construction, Charging & discharging, recent trends in manufacturing of batteries.

Unit3 Lighting: Requirement of good lighting, Classification of light fitting & luminaries, Factor to be considered for design of indoor & outdoor lighting scheme, Design procedure for factory lighting, flood lighting & street lighting.

Unit4 Electrical Heating: Advantages of electrical heating, Resistance heating, Design of heating element in resistance oven, Control of temperature in resistance oven, Electric arc furnaces, Induction furnaces, Dielectric heating.

Electric Welding: Electric arc welding & Resistance welding, Modern welding techniques like Ultrasonic & Laser welding.

Unit5 Electric Traction: Different systems of traction, Advantages & disadvantages, Systems of track electrification, Speed-time curve, Tract effort, Adhesive weight, Coefficient of adhesion, Specific energy consumption, Power supply arrangements, Current collecting systems

Unit6 Desirable characteristics of traction motors, Suitable motors for traction, Control of D.C. traction motors, Shunt transition, Bridge transition, Regenerative braking, Study of performance, operation & metering system, D.C. & A. C. transition.

References

1. Taylor E. O., 'Utilisation of Electical Enginering', Longman.
2. Partab H. P., 'Art & Science of Utilisation of Electical Enginering' Dhanpat Rai Publications.
3. Gupta J. B., 'Utilization of Electric Power & Electric Traction' S. K. Kataria & Sons.
4. Uppal S. L. , 'Electrical Power', Khanna Book Publication.

Course Outcomes :

A. Learner will be able to understand significance of electrical drives and components for industrial utility.
B. Develop an ability to compare different types of drives, and equipments and also will be able to choose a proper one as per the requirement of the problem.
C. An ability to design a system, a component to meet desired needs differentiate and will be able to compare different options based on results, and able to analyze and interpret results for different industrial application to meet desired needs within realistic constraints and confirms manufacturability
E. Students will build an ability to identify, formulate and solve industrial problems related to machine and equipment problems.
G. With the basic knowledge of the machines, equipments design and course, students will be able to develop computer programs for the utility and machine design techniques.
H. The Students will understand broad education necessary to understand the impact of electrical machine utilization and design solutions in a global and economical context.
I. Students will understand procedure-oriented and object oriented applications of electrical machine utility concepts.
K. Student will possess ability to use the techniques, skills, and modern engineering tools necessary for electrical machine utility practice.

Table 24: Mapping of course objectives with course outcome

Course Objectives	Course Outcomes										
	A	B	C	D	E	F	G	H	I	J	K
I	√	√			√				√		√
II	√						√	√	√		√
III		√			√			√	√		√
IV					√		√		√		√
V			√		√				√		√

Subject : EE802 – Energy Audit and Conservation

Course Objectives:

a. To review power scenario and substantiate use of renewable energy sources to substitute for energy crises.
b. To understand energy needs of different energy sector viz industry, commercial, agricultural, domestic and to calculate energy efficiency of energy conversion equipments used in different sector including utility.
c. To describe the need of energy audit and identify energy conservation measures for different energy sector.
d. To describe energy audit process and its application.
e. Review the basic concepts of energy process in different application.
f. Explain the economics of energy conversion and conservation for different energy sectors.

(EE802) ENERGY AUDIT AND CONSERVATION

Unit 1 Sources of Energy: Energy resources, Stored & running resources, Non-conventional energy sources, Necessity of conserving resources.

Unit 2 Energy In Industries: Energy inputs in industry, Comparison of various energy inputs, Use of electric energy in industries for motive power, Heating (Space, Furnace, Water), Lighting, Air conditioning, Welding, Energy efficiency of the apparatus in above energy conversion processes, Energy efficient design of above processes

Unit 3 Energy In Non-industrial Sector: Different forms of energy used in agricultural, commercial, domestic & municipal sectors

Unit 4 Energy Audit: Audit, A prerequisite for energy conservation, Principles of energy audit, Measurement & measuring devices, Analysis of data, Flow diagram, its use, ABC analysis.

Unit 5 Energy Conservation In Utilities: Energy conservation in generation, transmission, distribution & utilization, Demand side energy management, Energy efficient lighting system, Energy efficient drives-Critical study & analysis of certain case studies

Unit 6 Economics of Energy Conservations:
Energy Conservation: Energy conservation using energy audit data, Principles of energy conservation in industrial, commercial, domestic, agricultural & municipal sectors, Planning, Implementation & monitoring of energy conservation project, payback period calculations.

References

2. Sukhatme S.P., 'Solar Energy : Principles of thermal collection and storage' Tata-McGraw Hill
3. Keth & Fecher, 'Energy Efficiency Handbook' CRC Publication
4. Sinha H. P., 'Power System-I' Khanna Publication

Course Outcomes:

A. Learner will apply knowledge of science and engineering to substantiate use of renewable energy sources and to identify efficient energy conservation measures.
B. Students will able to analyze energy scenario, energy consumption and identify suitable energy efficient device to improve energy efficiency of system.
D. Students will able to apply knowledge to solve problems on analysis of multidisciplinary teams.
E. Student will be able to apply knowledge to solve numerical by understanding energy conversion and conservation process
J. Student will be able to understand the concept of energy audit and conservation measures in different energy sectors.
K. Learners will able to apply knowledge of engineering in to improve economic and environment issues for a given application.

Table 25 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√	√		√	√						√
2	√			√	√					√	√
3	√			√	√					√	√
4	√			√	√					√	√
5	√	√		√	√					√	√
6		√		√	√					√	√

Subject : EE803 – High Voltage Engineering

Course Objectives:

1. To prepare students for Basic understanding of the conceptual and practical approach of failure of engineering material.
2. To understand different techniques of failure of dielectric material.
3. To understand the different methods of high voltage generation applied in industries and in research laboratory.
4. To understand the different methods of high voltage measurement applied in industries and in research laboratory.

(EE803) HIGH VOLTAGE ENGINEERING

Unit 1 Conduction & breakdown in gases: Gases as insulation media, ionization processes, Townsend's current growth equation, current growth in presence of secondary processes, Townsend's criterion for breakdown in electronegative gases, time lags for breakdown, Streamers theory, Paschen's law, breakdown in non-uniform fields and corona discharge, corona under positive & negative polarities, glow & arc discharge, considerations in using gases for insulation purpose.

Unit 2 Conduction & breakdown in liquid dielectrics: Pure and commercial liquids, breakdown in pure and commercial liquids, theories of breakdown in liquids.
Breakdown in solid dielectrics: Intrinsic, electromechanical & thermal breakdown, chemical, electrochemical deterioration, treeing, tracking, internal discharges, breakdown in composite insulation, properties of solid insulators & other materials used in practice.
Insulating materials: In power transformers, rotating machines, circuit breakers, cables, power capacitors & other equipments.

Unit 3 Over voltage due to lightening phenomenon: propagation of lightning voltage & current waves on transmission lines, reflection & transmission of traveling wave at junction, system control of over voltage due to switching protection of transmission lines against over voltage. Insulation co-ordination, surge diverters, equipment insulation level & co-ordination of substations.

Unit 4 Generation of high voltages & currents: generation of a) high d. c voltage b) power frequency high alternating voltage c) high frequency a. c. d) impulse voltages Standard impulse waves shapes and it's equation, multistage impulse generator, matrix circuit, generation of switching surges, tripping & control of impulse generators, generation of impulse currents.

Unit 5 Measurement of high voltages & currents: Measurement of high d. c., power frequency a. c., high frequency a. c., & impulse current, measurement of resistivity, dielectric constant & loss factor, partial discharges measurement, radio interference measurement.

Unit 6 I. E. C. & IS codes for high voltage tests on electrical appliances & power apparatus & electrical motors, non- destructive testing, testing of insulators, bushings, isolators, circuit breakers, cables, transformers, surge diverter, layout of high voltage laboratories & test facilities.

References

1. Kamaraju V. & Naidu M. S., 'High Voltage Engineering', Tata-McGraw Hill
2. C. L. Wadhwa, "High Voltage Engineering", New Age International Pvt. Ltd
3. Subir Ray, "An Introduction to High Voltage Engineering", Prentice_Hall of India Pvt. Ltd.

Course Outcomes:

C. The will understand the electrical failure of the different engineering materials used in real life of industries.
D. Students will be able to understand importance of material study, and physics.
E. They will be able to generate the high voltages for A.C. and D. C. supply systems.
G. They will do the measurement of high voltages for A.C. and D. C. systems.
I. They will learn the high voltage wave propagation phenomenon.
K. Learners will able to apply knowledge of engineering in to improve economic and environment issues for a given application.

Table 26 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1							√				
2				√					√		
3			√								
4					√						√

(EE804) ELECTIVE – V : ELEMENTS OF PROJECT MANAGEMENT

Unit 1 Concept of Product & Project: a) Concept of products & projects, Standard & customized products, Scope & definition of project, Concept of turnkey projects & green field project, feasibility, Study. b) Types of projects, expansions & modernization, typical examples.

Unit 2 Project Planning: Importance of project planning, Resources planning considerations in choice of project, Site & Location, Planning statement of work, Planning major milestones, Planning cycle, Project co-ordination, monitoring & control.

Unit 3 Phases of Project: Categories of project, Phases of project lifecycle, Role & responsibility of project manager & skill requirements.
Project Organization: Traditional organization, Line- staff organization, Matrix organization, Modification of matrix, Structure in small company.

Unit 4 Forecasting and Planning Techniques: Project scheduling, concept of activities & event, Bar charts & run charts in project scheduling, Programme evaluation & review techniques (PERT) & Critical path method (C. P. M.) in project management, Activity scheduling & networking, Concept of optimistic & realistic times, Float availability & numerical.

Unit 5 Project costing & Budgeting: Project costing & budgeting, On line cost, Overhead rates, material support cost, Cash flow management, Cost overruns & their control, Application of just in time (J. I. T.) in cost control.

Unit 6 Electrical Project Management: Choice & grading of major electrical equipments, And systeming in project management, Economics of single v/s multiple units, Co-ordination of ratings of equipments in electrical projects.

References

1. Harold Kertzner & Cyrric O' Donald, ' Principles & Practice of Management
2. Joseph K. Manclass, 'Entrepreneurship & Venture Management'

(EE804) ELECTIVE – V : ROBOTICS AND AUTOMATION

Unit 1 Introduction: Need for automation, robotics fundamentals, classification of robots based on co-ordination system, method of components of robotics, flexible automation.

Unit 2 Mechanical system: Components of robot manipulator, controller, sensory devices, ower conversion unit, motion conversion, rotary to rotary, rotary to linear, linkages , modeling of mechanical system, translation, rotational, kinetic chain, Langragian analysis of manipulator, end vector, control of robotic joint

Unit 3 Transformation and Kinematics: Homogeneous co- ordinate vector operation, co-ordinates reference frames, homogeneous transformation and manipulator orientation, relative point, reference frame, Denavit Hankenberg (D-H)matrix, inverse of back solution.

Unit 4 Problems of obtaining inverse back solution, techniques using direct and geometric approach motion, generation, position trajectory, velocity profile, Cartesian motion of manipulator, Jacobian in terms of D-H matrix

Unit 5 Computer consideration for robotic system: Robot programming, fixed instruction, sequence control, general programming languages, specfic programming language. Consideration

Unit 6 Artificial intelligence and robotics: Artificial intelligence ,real time consideration, event driven processes, sensor information process, path planning, co- ordination motion, automatic programming

References

1. Klafter R. D .,Chmielewski T. A., Negin M., ‘ Robotic Engineering an integrated approach’ Prentice Hall
2. Fu K.S., Lee C. S. and Gonzalez R.C., ‘ Robotics: Control, Sensing, Vision and Intelligence ’ McGraw Hill

(EE804) ELECTIVE – V : MICROCONTROLLER AND INTERFACING

Unit 1 8051 Microcontroller: Introduction, Internal Architecture and other details of the chip, compare microcontrollers vs microprocessors

Unit 2 Instruction set of microcontroller 8051.

Unit 3 Addressing modes of 8051 microcontroller, programming techniques and assembly language programming.

Unit 4 Timer/Counter mode operation and Programming, Interrupts of 8051 microcontroller and programming.

Unit 5 Real World Interfacing – I : Interfacing of LCD, ADC, sensors.

Unit 6 Real World Interfacing – II : Interfacing of stepper motor, Keyboard, DAC.

References

1. Mazidi M. A., Mazidi J. G., ‘ 8051 Microcontroller and Embedded Systems’, Pearson Education
2. Ayala K. J.., 8051 ‘ Microcontroller: Architecture, Programming and Applications, Penram International

(EE804) ELECTIVE-V (DIGITAL SIGNAL PROCESSING)

Unit 1 Characterization & Classification of Digital Signals: Digital Signal Processing of continuous signals. Discrete time signals- sequences, representation of signals on orthogonal basis, sampling, aliasing, quantization & reconstruction of signal.

Unit 2 Discrete systems: attributes, z-transform, analysis of LTI system. Frequency analysis, inverse systems, Discrete Fourier transform. Fast Fourier implementation of discrete time system.

Unit 3 Digital filters: structures, sampling, recursive, non-recursive A to D & D to A conversion. FIR, IIR & lattice filter structures, Design of FIR digital filters. Window method, Park McCellan's method. Design of IIR digital filters. Butterworth, chebyshev, elliptic approximations, low-pass, band-pass, band-stop & high-pass filters. Effect of finite register length in FIR filter design.

Unit 4 Multirate signal processing: motivation-application, decimation & interpolation, sample rate conversion, polyphase implementation of sampling rate conversion, Filter bank theory- DFT filter banks, Adaptive filtering theory.

Unit 5 DSP Processors and Applications: DSP Microprocessor architectures, fixed point, floating point precision, algorithm design, mathematical, structural and numerical constraints.

Unit 6 DSP programming, filtering, data conversion; communication application. Real time processing considerations including interrupts.

References NPTEL courses.

Subject : EE805 – Power System Stability and Analysis

Course Objectives:

1. Students should able to use mathematical tools and engineering knowledge for problem formulation.
2. Learner should able to use various numerical methods for power system analysis.
3. Learner can analyze power network behavior under normal and abnormal conditions.
4. Students should able to understand and analyze functioning of mechanical systems in power system stability analysis.

(EE805) POWER SYSTEM STABILITY AND ANALYSIS

Unit 1 Modeling of Power system components: Transmission lines, Power transformer, Phase shifting transformer, Tap changing transformers, Synchronous Machine, Lighting arresters, Loads.

Unit 2 Power Flow Analysis: Solution of Power flow equation by Gauss Seidal and Newton Raphson method, Decoupled load flow, Fast decoupled load flow (FDLF).

Unit 3 Fault Analysis by Computer methods: Programmable method for formulating [Z] – sequence fault impedance matrix, general fault analysis equation, line current calculation.

Unit 4 Transient Stability: Solution of Swing equation using classical model, application of equal area creation on point by point solution

Unit 5 Power system Dynamic Performance: Effects of various types of disturbance parameters and controls on stability.

Unit 6 Effect of excitation control and turbine governing. Augmentation of stability of conventional methods.

References

1. Gross C. A., 'Power System Analysis' McGraw Hill
2. Arrilaga J., 'Computerised Power system Analysis' McGraw Hill
3. Foud Anderson, 'Power system control dynamics' McGraw Hill
4. Kaushik, 'Computerised Power system Analysis' McGraw Hill
5. Padiyar K. R., 'Power system dynamics, ' New Age International

Course Outcomes:

A. Learner will apply knowledge of science, engineering and mathematics to analyze power system networks.
B. Learner will able to analyze power network data.
D. Learner will understand the importance of multidisciplinary support and team efforts.
H. Students will understand the impact of engineering solutions in a global, economical, environmental and social context.
J. Learner will be guided to study various subjects.
K. Students will have an ability to use technical skills, and modern engineering tools necessary for engineering practice and trained to get jobs in core engineering field in MNCs.

Table 27 : Mapping of course objectives with course outcomes

Course Objectives	Course Outcomes										
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
1	√	√		√				√			√
2	√	√		√							
3				√				√			
4				√				√			√