UNIVERSITY OF LUCKNOW
FACULTY OF ENGINEERING & TECHNOLOGY

Evaluation Scheme for B. Tech.

Branch : Electrical Engineering

SEMESTER – V

S. No.	Subject Code	Subject Name	L-T-P	Evaluation					Credit
				Sessional			ESE	Grand Total	
				CT	TA	Total			
	Theory								
01.	EE – 501	Power System - I	**3--1--0**	**20**	**10**	**30**	**70**	**100**	**4**
02.	EE – 502	Control Systems	**3--1--0**	**20**	**10**	**30**	**70**	**100**	**4**
03.	EE – 503	Electrical and Electronics Engineering Materials	**3--0--0**	**20**	**10**	**30**	**70**	**100**	**3**
04.	EE - 504	Advanced Electrical Machines	**3--0--0**	**20**	**10**	**30**	**70**	**100**	**3**
05.	EC– 501	Principles of Communication Engineering	**3--1--0**	**20**	**10**	**30**	**70**	**100**	**4**
	Practical								
06.	EE – 551	Power System Lab - I	**0--0--3**	**-**	**40**	**40**	**60**	**100**	**2**
07.	EE – 552	Control System Lab	**0--0--2**	**-**	**20**	**20**	**30**	**50**	**1**
08.	EE – 553	Electrical Design and Fabrication Lab	**0--0--3**	**-**	**40**	**40**	**60**	**100**	**2**
09.	EC - 555	Principles of Communication Engineering Lab	**0--0--2**	**-**	**20**	**20**	**30**	**50**	**1**
10.	GP - 501	General Proficiency				**50**		**50**	
Total			**15-3-10**					**800**	**24**

Abbreviations : CT - Class Test TA - Teacher's Assessment
ESE - End Semester Examination

UNIVERSITY OF LUCKNOW
FACULTY OF ENGINEERING & TECHNOLOGY

Evaluation Scheme for B. Tech.

Branch : Electrical Engineering

SEMESTER - VI

S. No.	Subject Code	Subject Name	L-T-P	Evaluation					Credit
				Sessional			ESE	Grand Total	
				CT	TA	Total			
	Theory								
01.	EE – 601	Power system - II	3--1--0	20	10	30	70	100	4
02.	EE – 602	Power Electronics	3--1--0	20	10	30	70	100	4
03.	EE – 603	Advanced Control Systems	3--1--0	20	10	30	70	100	4
04.	EE – 604	Power Station Practice	3--0--0	20	10	30	70	100	3
05.	EE - 605	Any one from the list (DE -1)	3--0--0	20	10	30	70	100	3
	Practical								
06.	EE – 651	Power System Lab - II	0--0--2	-	20	20	30	50	1
07.	EE - 652	Power Electronics Lab	0--0--2	-	20	20	30	50	1
08.	EE – 653	Mini Project	0--0--3	-	40	40	60	100	2
09.	EE – 654	Seminar	0--0--3	-	40	40	60	100	2
10.	GP - 601	General Proficiency				**50**		**50**	
Total			**15-3-10**					**800**	**24**

Abbreviations : CT - Class Test TA - Teacher's Assessment
ESE - End Semester Examination DE - Departmental Elective

Note: Students have to undergo Industrial Training for a period of six weeks during summer vacation. The report of Industrial Training will be submitted to the Head of the Department in the beginning of seventh semester.

Departmental Elective-1:-

EE – 6051	Computer aided power system analysis
EE – 6052	Electrical Machine Design
EE – 6053	Utilization of Electrical Energy and Traction
EE – 6054	Fundamentals of Digital Signal Processing
EE – 6055	Artificial Neural Networks and Fuzzy system

EE – 501
POWER SYSTEM - I

L	T	P
3	1	0

UNIT-I

Power System Components: Single line diagram of power system; Brief description of power system elements: Synchronous machines. Transformers, transmission lines, busbar, circuit breaker and isolator etc.

Supply System: Different kinds of supply system and their comparison, choice of transmission voltage.

Transmission Lines: Conductor materials, types of conductors, resistance of line, Kelvin's law, current distortion effects: skin effect, proximity effect. **08**

UNIT-II

Over Head Transmission Lines: Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit transmission lines; Interference with communication lines, Reduction methods; Representation and performance of short, medium and long transmission lines, Ferranti effect, surge impedance loading. **10**

UNIT-III

Mechanical Design of Transmission Lines: Catenary curve, calculation of sag & tension, stringing chart, effects of wind and ice loading, sag template, vibration dampers

Overhead Line Insulators: Type of insulators and their applications, potential distribution over a string of insulators, methods of equalizing the potential, string efficiency. **08**

UNIT-IV

Corona and Interference: Phenomenon of corona, corona formation, calculation of potential gradient, corona loss, factors affecting corona, methods of reducing corona.

Insulated Cables: Type of cables, construction and their applications; dielectric stress, grading of cables, insulation resistance, capacitance of single phase and three phase cables, dielectric loss, heating of cables. **06**

UNIT-V

Neutral Grounding: Necessity of neutral grounding, various methods of neutral grounding, earthing transformer, grounding practices.

Electrical Design of Transmission Line: Design consideration of EHV transmission lines, choice of voltage, number of circuits, conductor configuration, insulation design, selection of ground wires.

EHV AC and HVDC Transmission: Introduction to EHV AC and HVDC transmission and their comparison, use of bundle conductors, kinds of DC links and incorporation of HVDC into AC system. **08**

Text Books:

1. W. D. Stevenson, "Elements of Power System Analysis", Tata McGraw Hill Publishing Co.
2. C. L. Wadhwa, "Electrical Power Systems", New Age International Ltd.
3. Ashfaq Hussain, "Electrical Power Systems", CBS Publishers and Distributors.
4. B. R. Gupta, "Power System Analysis and Design", S. Chand & Co.
5. M. V. Deshpande, "Electrical Power Systems Design", Tata McGraw Hill Publishing Co. Ltd.

Reference Books:

1. M. L. Soni, P.V. Gupta and U. S. Bhatnagar, "A Course in Electrical Power", Dhanpat Rai & Sons.
2. S. L. Uppal, "Electrical Power Systems", Khanna Publishers.
3. S. N. Singh, "Electric Power Generation, Transmission & Distribution", PHI Learning Pvt. Ltd.

EE – 502
CONTROL SYSTEMS

L	T	P
3	1	0

UNIT-I

The Control System: Open loop & close loop control, servomechanism, physical examples. Modelling of mechanical, electrical and electro-mechanical systems by differential equations, analogy between electrical and mechanical systems.

Transfer functions and its properties, block diagram algebra, signal flow graph, basic characteristics of feedback systems, modes of feedback control, the performance of feedback systems, Mason's gain formula, Reduction of parameter variation and effects of disturbance by using negative feedback**.** **08**

UNIT-II

Time Response Analysis: Standard test signals, time response of first and second order systems, time response specifications, steady state errors and error constants

Design Specifications of Second Order Systems: Derivative error, derivative output, integral error and PID compensations, design considerations for higher order systems, performance indices. **08**

UNIT-III

Control System Components: Constructional and working concept of ac servomotor, synchros and stepper motor.

Stability and Algebraic Criteria: concept of stability and necessary conditions, Routh-Hurwitz criteria and limitations.

Root Locus Technique: Concepts of root locus, construction of root loci, effect of transportation lag and Root locus of non-minimal phase system and effect of pole-zero cancellation. **08**

UNIT-IV

Frequency Response Analysis: Frequency response analysis from transfer function model, correlation between time and frequency responses, polar and inverse polar plots, Bode plots

Stability in Frequency Domain: Nyquist stability criterion, assessment of relative stability: gain margin and phase margin; Close loop frequency response: Constant M&N circles **08**

UNIT-V

Introduction to Design: The design problem and preliminary considerations; Realization of basic compensators: lead, lag and lead- lag, design of closed loop systems using compensation techniques in time domain and frequency domain.

Review of State Variable Technique: The concept of state & space, state-space model of physical system, conversion of state variable model to transfer function model and vice-versa, diagonalization, controllability and observability and their testing. **08**

Text Books:

1. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International Ltd.
2. K. Ogata, "Modern Control Engineering", PHI Learning Pvt. Ltd.
3. B. C. Kuo and F. Golnaraghi, "Automatic Control Systems", Wiley India Ltd.
4. D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd.

Reference Books:

1. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons Inc.
2. R.T. Stefani, B. Shahian, C. J. Savant and G.H. Hostetter, "Design of Feedback Control Systems", Oxford University Press.

EE – 503
ELECTRICAL AND ELECTRONICS ENGINEERING MATERIALS

L	T	P
3	0	0

UNIT- I

Crystal Structure of Materials: Bonds in solids, crystal structure, co-ordination number, atomic packing factor, Miller Indices, Bragg's law and x-ray diffraction, structural imperfections, crystal growth. Energy bands in solids, classification of materials using energy band. **08**

UNIT-II

Conductivity of Metals: Electron theory of metals, factors affecting electrical resistance of materials, thermal conductivity of metals, heat developed in current carrying conductors, thermoelectric effect, superconductivity and super conducting materials, properties and applications of electrical conducting and insulating materials, mechanical properties of metals. **08**

UNIT-III

Mechanism of Conduction in semiconductor materials: Types of semiconductors, current carriers in semiconductors, Half effect, Drift and Diffusion currents, continuity equation, P-N junction diode, junction transistor, FET & IGFET, properties of semiconducting materials. **08**

UNIT-IV

Magnetic Properties of Material: Origin of permanent magnetic dipoles in matters, Classification: Diamagnetism, Para magnetism, Ferromagnetism, Anti-Ferro-magnetism and Ferrimagnetism, magnetostriction, properties of magnetic materials, soft and hard magnetic materials and permanent magnetic materials. **08**

UNIT-V

Materials Selection and Optical Properties: Material properties and Engineering Design parameters; General effects of processing on parameters; selection of structural design. Light interaction with solids; Absorption, Transmission and Reflection; Luminescence; Photoconductivity. **08**

Text Books:

1. L. H. Van Vlack, "Elements of Materials Science and Engineering", Pearson Education India.
2. V. Raghavan, "Materials Science and Engineering: A First Course", PHI Learning Pvt. Ltd.
3. V. S. R. Murthy, A. K. Jena, K. P. Gupta and G. S. Murty, "Structure and Properties of Engineering Materials", Tata McGraw Hill Publishing Co. Ltd.
4. J. F. Shackelford, "Introduction to Materials Science for Engineers", Pearson.
5. C. S. Indulkar and S. Thiruvengadam, "An Introduction to Electrical Engg. Materials", S. Chand & Co.

Reference Books:

1. L. Solymar and D. Walsh, "Electrical Properties of Materials", Oxford University Press.
2. I. P. Jones, "Materials Science for Electrical and Electronic Engineers", Oxford University Press.

EE – 504
ADVANCED ELECTRICAL MACHINES

L	T	P
3	0	0

UNIT I

Poly-phase AC Machines: Construction and performance of double cage and deep bar three phase induction motors; e.m.f. injection in rotor circuit of slip ring induction motor, concept of constant torque and constant power controls, static slip power recovery control schemes (constant torque and constant power). **08**

UNIT-II

Induction Generator: Self-excited Induction Generator **(**SEIG), Doubly-fed Induction Generator (DFIG): Operating Principle, Equivalent Circuit, Characteristics, Applications.

Two Phase AC Servomotors: Construction, torque-speed characteristics, performance and applications. **06**

UNIT-III

Stepper Motors: Principle of operation, variable reluctance, permanent magnet and hybrid stepper motors, characteristics, drive circuits and applications.

Switched Reluctance Motors: Construction; principle of operation; torque production, modes of operation, drive circuits. **08**

UNIT-IV

Permanent Magnet Machines: Types of permanent magnets and their magnetization characteristics, demagnetizing effect, permanent magnet dc motors, sinusoidal PM AC motors, brushless dc motors and their important features and applications, PCB motors. Single phase synchronous motor; construction, operating principle and characteristics of reluctance and hysteresis motors; introduction to permanent magnet generators and applications. **10**

UNIT-V

Single Phase Commutator Motors: Construction, principle of operation, characteristics of universal and repulsion motors.

Linear Induction Motors: Construction, principle of operation, linear force, and applications. **08**

Text Books:

1. P.S. Bimbhra, "Generalized Theory of Electrical Machines" Khanna Publisher.
2. P.C. Sen, "Principles of Electrical Machines and Power Electronics", John Wiley & Sons.
3. D. P. Kothari and I. J. Nagrath, "Electric Machines", Tata McGraw Hill Publishing Co. Ltd.

Reference Books:

1. C. G. Veinott, "Fractional and Sub-fractional Horse Power Electric Motors", Tata McGraw Hill Publishing Co. Ltd.
2. M.G. Say, "Alternating current Machines" Pitman & Sons.
3. I. L. Kosow, "Electric Machinary and Transformers", PHI Learning Pvt. Ltd.

EC - 501
PRINCIPLES OF COMMUNICATION ENGINEERING

L	T	P
3	1	0

Unit-I

Introduction: Overview of Communication system, communication channels, need for modulation, base band and pass band signals. Amplitude Modulation : Double side band with carrier (DSB-C), double side band without carrier, single side band modulation, DSB-SC, DSB-C, SSB modulators and demodulators, vestigial side band (VSB), quadrature amplitude modulator. **08**

Unit-II

Angle modulation, modulation index, pre-emphasis & de-emphasis, tone modulated FM signal, arbitrary modulated FM signal, FM modulators, direct method & indirect method and demodulators, PLL, phase discriminator & ratio detector, PM modulator and demodulator, stereophonic FM broadcasting, **08**

Unit-III

Pulse Modulation Digital Transmission of Analog Signals: Sampling theorem and its applications, pulse amplitude modulation (PAM), pulse width modulation, pulse position modulation, their generation and demodulation, digital representation of analog signals. Pulse Code Modulation (PCM) and PCM system. Issues in Digital Transmission: Frequency division multiplexing, time division multiplexing ,line coding and their power spectral density. **08**

Unit-IV

Differential pulse code modulation, delta modulation. adaptive delta modulation, T1 digital system, TDM hierarchy, Noise in Amplitude Modulation: Analysis, signal to noise ratio, figure of merit, noise in frequency modulation **08**

Unit-V

Noise: Types of noise and their sources, noise calculation, noise due to several amplifiers in cascade, noise in reactive circuits, noise figure & noise temperature calculation. **08**

Text Book:

1. H. Taub, D. Schilling, GoutomSaha, "Principles of Communication Systems", 4th Edition, TataMcGraw-Hill Publishing Company Ltd.
2. R.P. Singh, & S.D Sapre, "Communication Systems: Analog & Digital", 3rd Edition McGraw Hill Education.
3. B.P. Lathi, "Modern Digital and Analog communication Systems", 3rd Edition, Oxford University Press,2009.

Reference Books:

1. G. Kennedy, B. Devis, S. R. M. Prasanna, "Electronic Communication Systems" 5th Edition, Tata McGraw-Hill Publishing Company Ltd.
2. Simon Haykin, "Communication Systems",4th Edition, Wiley India.
3. H. Hsu & D. Mitra , "Analog and Digital Communications", 2nd Edition, Tata McGraw-Hill Publishing Company Ltd.

EE – 551
POWER SYSTEM LAB – I

L	T	P
0	0	3

Note :- At least **ten** experiments are to be conducted from the following list.

1. To study basic components of power system.
2. To calculate voltage regulation of a transmission line.
3. To find out the voltage distribution across the string of insulator with and without guard ring and calculate string efficiency.
4. To determine the dielectric strength of transformer oil.
5. Determination of R, L and C parameters of a transmission line model and observing the Ferranti effect.
6. Determination of A, B, C, D parameters, Hybrid parameter and Image parameter of a transmission line model.
7. To plot the equipotential line of paper model of single layer and multilayer cables.
8. To find location of fault in Cable by bridge method.
9. To study the performance characteristics of a typical dc distribution system (ring configuration).
10. To study the performance characteristics of a typical dc distribution system (radial configuration)

EE – 552
CONTROL SYSTEM LAB

L	T	P
0	0	2

Note :- At least **ten** experiments are to be conducted from the following list.

1. To determine response of first order and second order systems for step input for various values of constant 'K' using linear simulator unit and compare theoretical and practical results.
2. To study P, PI and PID temperature controller for an oven and compare their performance.
3. To study the potentiometer as error detector for DC/AC excitation.
4. To study and calibrate temperature using resistance temperature detector (RTD).
5. To design Lag, Lead and Lag-Lead compensators using Bode plot.
6. To study the relay characteristics and display of the same on CRO for different values of hysteresis and dead zone.
7. To study DC position control system.
8. To study synchro-transmitter and receiver and obtain output V/S input characteristics
9. To determine speed-torque characteristics of an ac servomotor.
10. To study performance of servo voltage stabilizer at various loads using load bank.
11. To study behavior of separately excited dc motor in open loop and closed loop conditions at various loads.
12. To study PID Controller for simulation proves like transportation lag.

Software based experiments (Use MATLAB, LABVIEW software etc.)

13. To determine time domain response of a second order system for step input and obtain Performance parameters.
14. To convert transfer function of a system into state space form and vice-versa.
15. To plot root locus diagram of an open loop transfer function and determine range of gain 'k' for stability.
16. To plot a Bode diagram of an open loop transfer function.
17. To draw a Nyquist plot of an open loop transfer functions and examines the stability of the closed loop system.

EE – 553
ELECTRICAL DESIGN & FABRICATION LAB

L	T	P
0	0	3

Note :- At least **ten** experiments are to be conducted from the following list.

1. Design & Fabrication of Power amplifier.
2. Small Power Supply design & Fabrication.
3. Transformer design & Fabrication.
4. Controller design & Fabrication.
5. Design & Fabrication of chopper.
6. Design & Fabrication of High-Power factor-controlled rectifier.
7. Inductor design and Fabrication.
8. Design & Fabrication of Microcontroller based digital energy meters / sensors.
9. Design Fabrication of AC phase converter and its firing circuit.
10. IGBT based single phase inverter design and Fabrication.
11. Filter design & Fabrication.

EC - 555
PRINCIPLES OF COMMUNICATION ENGINEERING LAB

L	T	P
0	0	2

Note :- At least **ten** experiments are to be conducted from the following list.

1. To study DSB/ SSB amplitude modulation & determine its modulation Index & power in side bands.
2. To study amplitude demodulation by linear diode detector.
3. To study frequency modulation and determine its modulation factor.
4. To study PLL 565 as frequency demodulator.
5. To study sampling and reconstruction of Pulse Amplitude modulation system.
6. To study the Sensitivity, Selectivity, and Fidelity characteristics of super heterodyne receiver.
7. To study Pulse Amplitude Modulation.
   a) using switching method
   b) by sample and hold circuit
8. To demodulate the obtained PAM signal by 2nd order LPF.
9. To study Pulse Width Modulation and Pulse Position Modulation.
10. To study Pulse code modulation and demodulation technique.
11. To study Delta modulation and demodulation technique.
12. Design and implement an FM radio receiver in 88-108 MHz

EE – 601
POWER SYSTEM – II

L	T	P
3	1	0

UNIT-I

Representation of Power System Components: Synchronous machines, transformers, transmission lines, one-line diagram, impedance and reactance diagram, per unit system

Symmetrical components: Symmetrical components of unbalanced phasors, power in terms of symmetrical components, sequence impedances and sequence networks.

Symmetrical fault analysis: Transient in R-L series circuit, calculation of 3-phase short circuit current and reactance of synchronous machine, internal voltage of loaded machines under transient conditions. **08**

UNIT-II

Unsymmetrical faults: Analysis of single line-to-ground fault, line-to-line fault and double line-to-ground fault on an unloaded generators and power system network with and without fault impedance, formation of Z-bus using singular transformation. **08**

UNIT-III

Load Flows: Introduction, bus classifications, nodal admittance matrix (Y-bus), development of load flow equations, load flow solution using Gauss-Seidel and Newton-Raphson methods, approximation to N-R method, line flow equations and fast decoupled method. **08**

UNIT-IV

Power System Stability: Stability and Stability limit, Steady state stability study, Swing equation, transient stability studies by equal area criterion and step-by-step method. Factors affecting steady state and transient stability and methods of improvement. **08**

UNIT-V

Traveling Waves: Wave equation for uniform transmission lines, velocity of propagation, surge impedance, reflection and transmission of traveling waves under different line loadings, standing wave ratio, Bewlay's lattice diagram, protection of equipment's and line against traveling waves. **08**

Text Books:

1. W.D. Stevenson, "Elements of Power System Analysis", Tata McGraw Hill Publishing Co. Ltd.
2. C.L. Wadhwa, "Electrical Power Systems", New Age International Ltd.
3. A. Chakrabarti, M. L. Soni, P. V. Gupta and U. S. Bhatnagar, "A Text Book on Power System Engineering", Dhanpat Rai & Co.
4. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", Tata McGraw Hill Publishing Co. Ltd.

Reference Books:

1. Hadi Sadat, "Power Systems Analysis", Tata McGraw Hill Publishing Co. Ltd.
2. J. D. Glover, M.S. Sharma and T. J. Overbye, "Power System Analysis and Design", Cengage Learning.
3. P. S. R. Murty, "Power System Analysis", B. S. Publications.
4. G. W. Stagg and A. H. El-Abiad, "Computer Methods in Power System Analysis", Tata McGraw Hill Publishing Co. Ltd.

EE – 602
POWER ELECTRONICS

L	T	P
3	1	0

UNIT-I

Power semiconductor Devices: Power semiconductor devices, their symbols and static characteristics; Characteristics and specifications of switches, types of power electronic circuits.

Power Diodes: General purpose diode, Fast recovery diode, Schottky diode and its applications.

Power Bipolar Junction Transistors: Physical structure and device operation, static V-I and switching characteristics, switching limits of power transistor.

Power MOSFETS: Physical structure and device operation, Static V-I characteristics and switching characteristics, safe operating area.

Insulated Gated Bipolar Transistors: Physical structure and device operation, static V-I characteristics, safe operating area.

Thyristor: Physical structure and device operation, static V-I characteristics, two transistor model, methods of turn-on.

GTO (Gate Turn Off) Thyristors: Physical structure and device operation, static V-I and switching characteristics.

TRIAC: Physical structure and device operation, static V-I characteristics and applications.

Special Power Devices: Physical structure, device operation and static V-I characteristics of Reverse Conducting Thyristor (RCT), FET controlled thyristor, Static Induction Thyristors (SITH), MOS Controlled Thyristor (MCT), LASCR. **10**

UNIT-II

Power Semiconductor Devices (Contd): Protection of devices, series and parallel operation of thyristors, commutation techniques of thyristor.

DC-DC Converters: Introduction, Principle of chopper operation, Control strategies, Principles of step-down chopper, step-down chopper with R-L load, Principle of step-up chopper, and operation with R-L load, classification of choppers. **06**

UNIT-III

Phase Controlled Converters: Single-phase half wave controlled rectifier with resistive and inductive loads, effect of freewheeling diode. Single-phase fully controlled and half controlled bridge converters, performance parameters, Three-phase half wave converters, Three-phase fully controlled and half controlled bridge converters, effect of source impedance single-phase and three-phase dual converters. **08**

UNIT-IV

AC Voltage Controllers: Principle of On-Off and phase controls, Single-phase ac voltage controller with resistive and inductive loads, Three-phase ac voltage controllers (various configurations and comparison only) Single-phase transformer taps changer.

Cyclo-converters: Introduction, The basic principle of operation, single-phase to single-phase, three-phase to single-phase and three-phase to three-phase cyclo-converters, output voltage equation. **08**

UNIT-V

Inverters: Introduction, Single-phase series resonant inverter, Single-phase bridge inverters, Three-phase bridge inverters, voltage control of inverters, harmonics reduction techniques, Single-phase and three-phase current source inverters. **08**

Text Books:

1. M. H. Rashid, “Power Electronics: Circuits, Devices & Applications”, Pearson Education India.
2. M. D. Singh and K. B. Khanchandani, “Power Electronics”, Tata McGraw Hill Publishing Co. Ltd.
3. V. R. Moorthy, “Power Electronics: Devices, Circuits and Industrial Applications”, Oxford University Press.
4. B. Jayant Baliga, “Modern Power Devices”, Wiley-Interscience, NewYork.
5. S. N. Singh, “A Textbook of Power Electronics”, Dhanpat Rai & Sons.

Reference Books:

1. M. S. J. Asghar, “Power Electronics”, PHI Learning Pvt. Ltd.
2. A. Chakrabarti, “Fundamentals of Power Electronics & Drives”, Dhanpat Rai & Sons.
3. N. Mohan, T. M. Undeland and W. P. Robbins, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons Inc.
4. G. K. Dubey et al, “Thyristorised Power Controllers”, John Wiley & Sons Inc.
5. J. G. Kassakian, M. F. Schlecht and G. C. Verghese, “Principles of Power Electronics”, Pearson Education India.

EE – 603
ADVANCED CONTROL SYSTEMS

L	T	P
3	1	0

UNIT-I

State Space Analysis of Continuous System: Review of state variable representation of continuous system, conversion of state variable models to transfer function and vice-versa, solution of state equations and state transition matrix, controllability and observability, design of state observer and controller. **08**

UNIT-II

Analysis of Discrete System: Discrete system and discrete time signals, state variable model and transfer function model of discrete system, conversion of state variable model to transfer function model and vice-versa, modeling of sample hold circuit, solution of state difference equations, steady state accuracy, stability on the z-plane and Jury stability criterion, bilinear transformation, Routh-Hurwitz criterion on r^{th} planes. **08**

UNIT-III

Stability: Lyapunov's stability theorems for continuous and discrete systems, methods for generating Lyapunov function for continuous and discrete system, Popov's criterion.

Non-linear System: Types of non linearities, phenomena related to non - linear systems. Analysis of non- linear systems-Linearization method, second order non-linear system on the phase plane, types of phase portraits, singular points, system analysis by phase-plane method, describing function and its application to system analysis. **08**

UNIT-IV

Optimal Control: Introduction, formation of optimal control problem, calculus of variations minimization of functions, constrained optimization. Pontryagin's Minimum Maximum Principle, Linear Quadratic Problem-Hamilton Jacobi equation, Riccati equation and its solution. **08**

UNIT-V

Adaptive Control: Introduction, modal reference adaptive control systems, controller structure, self-tuning regulators; Introduction to neural network, Fuzzy logic and genetic algorithms. **08**

Text Books:

1. M. Gopal, "Digital Control and State variable Methods", Tata McGraw Hill Publishing Co. Ltd.
2. A. K. Mandal, "Introduction to Control Engineering: Modeling, Analysis and Design" New Age International.
3. S. Rajasekaran and G. A. V. Pai, "Neural Networks, Fuzzy Logic and Genetic Alogorithms: Synthesis and Applications" PHI Learning Pvt. Ltd.

Reference Book:

1. Donald E. Kirk, "Optimal Control Theory: An Introduction", Dover Publications.
2. B.C. Kuo, "Digital Control Systems" Saunders College Publishers.
3. C. H. Houpis and G. B. Lamont, "Digital Control Systems: Theory, Hardware, Software" Tata McGraw Hill Publishing Co. Ltd.

EE – 604
POWER STATION PRACTICE

L	T	P
3	0	0

UNIT-I

Introduction: Electric energy demand and growth in India, electric energy sources.

Thermal Power Plant: Site selection, general layout and operation of plant, detailed description and use of different parts.

Hydro Electric Plants: Classifications, location and site selection, detailed description of various components, general layout and operation of Plants, brief description of impulse, reaction, Kaplan and Francis turbines, advantages & disadvantages, hydro-potential in India. **08**

UNIT-II

Nuclear Power Plant: Location, site selection, general layout and operation of plant. Brief description of different types of reactors, moderator materials, fissile materials, control of nuclear reactors, disposal of nuclear waste material, shielding.

Gas Turbine Plant: Operational principle of gas turbine plant & its efficiency, fuels, open and closed-cycle plants, regeneration, inter-cooling and reheating, role and applications.

Diesel Plants: Diesel plant layout, components & their functions, its performance, role and applications. **08**

UNIT-III

Sub-stations Layout: Types of substations, bus-bar arrangements, typical layout of substation.

Power Plant Economics and Tariffs: Load curve, load duration curve, different factors related to plants and consumers, Cost of electrical energy, depreciation, generation cost, effect of load factor on unit cost. Fixed and operating cost of different plants, role of load diversity in power system economy; Objectives and forms of Tariff; Causes and effects of low power factor, advantages of power factor improvement, different methods for power factor improvements. **08**

UNIT-IV

Economic Operation of Power Systems: Characteristics of steam and hydro-plants, Constraints in operation, Economic load scheduling of thermal plants neglecting and considering transmission losses, Penalty factor, loss coefficients, incremental transmission loss; Hydrothermal Scheduling. **08**

UNIT-V

Non-Conventional Energy Sources: Power Crisis, future energy demand, role of private sectors in energy management,

MHD Generation: Working principle, open and closed cycles, MHD systems, advantages, parameters governing power output.

Solar Power Plant: Conversion of solar heat to electricity, solar energy collectors, photovoltaic cell, power generation, future prospects of solar energy use.

Wind Energy: Windmills, power output with combined operation of wind turbine generation and isolated generating system, technical choices & economic size.

Geothermal Energy: Earth energy, heat extraction, vapour turbine cycle, difficulties & disadvantages,

Tidal Energy: Tidal phenomenon, tidal barrage, tidal power schemes.

Ocean Thermal Energy: Introduction, energy conversion, problems. **08**

Text Books:

1. B. R. Gupta, "Generation of Electrical Energy", S. Chand Publication.
2. A. Chakrabarti, M. L. Soni, P. V. Gupta and U. S. Bhatnagar, "A textbook on Power System

Engineering", Dhanpat Rai & Sons Co.
3. P. S. R. Murthy, "Operation and control of Power System", B S Publications.

Reference Books:

1. W. D. Stevenson, "Elements of Power System Analysis", Tata McGraw Hill Publishing Co. Ltd.
2. S. L. Uppal and S. Rao, "Electrical Power Systems", Khanna Publishers.
3. M. V. Deshpande, "Elements of Electrical Power Station Design", PHI Learning Pvt. Ltd.

EE – 651
POWER SYSTEM LAB – II

L	T	P
0	0	2

Note :- At least **ten** experiments are to be conducted from the following list.

1. Determination of positive, negative and zero sequence impedances of a three phase transformer.
2. To determine negative and zero sequence reactances of an alternator.
3. To determine sub transient direct axis reactance (X_d") and sub transient quadrature axis reactance (X_q") of an alternator
4. To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation.
5. Study of symmetrical fault of a power system with generating sources.
6. To determine location of fault in a cable using cable fault locator.
7. Measurement & verification of active & reactive power flow. Compensation of VAR at the Receiving end using long line model.
8. To determine the wavelength of the transmission line from the standing wave ratio and compare this to the theoretical value using the line parameters.

Simulation Based Experiments (using MATLAB or any other software)

9. To determine transmission line performance.
10. To obtain steady state, transient and sub-transient short circuit currents in an alternator
11. Study of load flow analysis of a power system using (a) Gauss–Seidel and (b) Newton-Raphson methods.
12. To obtain formation of Y-bus and perform load flow analysis
13. To perform symmetrical fault analysis in a power system
14. To perform unsymmetrical fault analysis in a power system

EE – 652
POWER ELECTRONICS LAB

L	T	P
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Note :- At least **ten** experiments are to be conducted from the following list.

1. To study V-I characteristics of SCR and measure latching and holding currents.
2. To study R, RC and UJT trigger circuit for SCR.
3. To study the various commutation circuits for SCR.
4. To study single-phase half wave controlled rectifier with (i) resistive load (ii) inductive load with and without freewheeling diode.
5. To study single phase (i) fully controlled (ii) half controlled bridge rectifiers with resistive and inductive loads.
6. To study three-phase fully/half controlled bridge rectifier with resistive and inductive loads.
7. To study TRIAC based single-phase ac voltage regulator and determination of thyristor switching characteristics and pulse transformer characteristics.
8. To study single phase cyclo-converter.
9. To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor.
10. To study four quadrant operation of IGBT/MOSFET chopper circuit.
11. To study MOSFET/IGBT based single-phase series-resonant inverter.
12. To study MOSFET/IGBT based single-phase bridge inverter.

Simulation Based Experiments (using MATLAB or any other software)

13. To obtain simulation of SCR and GTO thyristor.
14. To obtain the simulation of single phase fully controlled bridge rectifier circuit.
15. To obtain simulation of single phase full wave ac voltage controller and draw load voltage and load current waveforms for inductive load.
16. To obtain simulation of step-down DC chopper with LC output filter for inductive load.

EE – 6051
COMPUTER AIDED POWER SYSTEM ANALYSIS

L	T	P
3	0	0

UNIT-I

Network Matrices: Evaluation of bus admittance matrix, bus impedance matrix, branch impedance matrix and loop Impedance matrix by singular and non-singular transformations. **08**

UNIT-II

Short Circuit Studies: Formulation of bus impedance matrix for single phase and three phase networks, transformation of network matrices using symmetrical components; Short circuit studies using bus impedance matrix, bus admittance matrix and loop impedance matrix. **06**

UNIT-III

Load Flow Studies: Representation of off-load, on-load tap changing and phase shifting transformers, DC link, Decoupled and fast decoupled methods, sparsity technique; Introduction to load flow of integrated AC/DC system. **08**

UNIT-IV

Stability Studies: Network formulation for stability studies for different types of loads (constant impedance, constant current and constant power loads), digital computer solution of swing equation for single and multi-machine cases using Runge-Kutta and predictor corrector methods, effects of exciter and governor on transient stability. **08**

UNIT-V

Voltage Stability: Transmission system characteristics, generator characteristics, load characteristics, introduction of reactive compensating devices, classification of voltage stability, voltage stability analysis, voltage collapse and its prevention.

Small-Signal Stability: Concept of stability of dynamic system, Eigen-properties of the state matrix, Single-machine infinite bus system, power system stabilizer. **10**

Text Books:

1. G. Kusic, "Computer-Aided Power System Analysis", CRC Press.
2. M. A. Pai and D. Chatterjee, "Computer Techniques in Power System Analysis", Tata McGraw Hill Publishing Co. Ltd.
3. P. Kundur, "Power System Stability and Control", Tata McGraw Hill Publishing Co. Ltd.

Reference Books:

1. G. W. Stagg and A. H. El-Abiad, "Computer Methods in Power System Analysis", Tata McGraw Hill Publishing Co. Ltd.
2. L. P. Singh, "Advanced Power System Analysis and Dynamics", John Wiley Sons & Co.

EE – 6052
ELECTRICAL MACHINE DESIGN

L	T	P
3	0	0

UNIT-I

Basic design principles and approaches, factors and limitations in design, specification, magnetic and electric loading, output equations and output coefficients, Main dimensions; Ratings, heating cooling and temperature rise, heating cooling curves, heating cooling cycles, estimation of maximum temperature rise, cooling media. **08**

UNIT-II

Transformer: Magnetic circuit, classification of magnetic materials and allowable flux densities, core construction and design, winding types, insulation, loss allocation and estimation, reactance, temperature rise. **08**

UNIT-III

DC Machine: No. of poles and main dimensions, armature windings, single layer, double layer, magnetic circuit and magnetization curve, commutator and brushes. **08**

UNIT-IV

3-phase Induction Machine: Rating specifications, standard frame sizes, main dimensions specific loadings, design of stator windings, rotor design-slots and windings, integral and fractional slot windings, winding factors , calculations of equivalent circuit parameters. **10**

UNIT-V

Computer assisted design of above machines. **06**

Text Books:

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai & Sons.
2. K. G. Upadhyay, "Conventional and Computer Aided Design of Electrical Machines" Galgotia Publications.

Reference Books:

1. M. G. Say, "The Performance and Design of Alternating Current Machines" Pitman & Sons.
2. A. E. Clayton and N.N. Hancock, "The Performance and Design of Direct Current Machines" Pitman & Sons.
3. S. K. Sen, "Principles of Electrical Machine Design with Computer Programs" Oxford and IBM Publications.

EE – 6053
UTILIZATION OF ELECTRICAL ENERGY AND TRACTION

L	T	P
3	0	0

UNIT-I

Electric Heating: Different methods of electric heating: Resistance heating, electric arc heating, principles of high frequency induction and dielectric heating. **08**

UNIT-II

Electric Welding: Electric arc welding, electric resistance welding, welding transformers, electronic welding control.

Electrolyte Process: Principles of electro deposition, laws of electrolysis, applications of electrolysis **08**

UNIT-III

Illumination: Various definitions, laws of illumination, requirements of good lighting, design of indoor lighting and outdoor lighting systems.

Refrigeration and Air Conditioning: Refrigeration systems, domestic refrigerator, water cooler Types of air conditioning, window air conditioner **08**

Unit-IV

Electric Traction-I: Types of electric traction, systems of track electrification, traction mechanics-types of services, speed time curve and its simplification, average and schedule speeds, tractive effort, specific energy consumption, mechanics of train movement, coefficient of adhesion and its influence **08**

UNIT-V

Electric Traction-II: Salient features of traction drives, various methods of starting and speed control of DC and AC drives used in traction, series – parallel control of dc traction drives (bridge transition) and energy saving, power electronic control of dc and ac traction drives, diesel electric traction. **08**

Text Books:

1. H. Partab, "Art and Science of Utilization of Electrical Energy", Dhanpat Rai & Sons.
2. H. Partab, "Modern Electric Traction", Dhanpat Rai & Sons.

Reference Books:

1. G. K. Dubey, "Fundamentals of Electric Drives", Narosa Publishing House.
2. C. L. Wadhwa, "Generation, Distribution and Utilization of Electrical Energy", New Age International Pvt. Ltd..

EE – 6054
FUNDAMENTAL OF DIGITAL SIGNAL PROCESSING

L	T	P
3	0	0

UNIT-I

Discrete-Time Signals and Systems: Sequences, discrete time systems, LTI systems, frequency domain representation of discrete time signals and systems, discrete time signals and frequency domain representation, Fourier Transform.

Discrete Fourier Transform: Discrete Fourier transforms, properties, linear convolution using DFT, DCT. **08**

UNIT-II

Sampling of Continuous Time Signals: Sampling and reconstruction of signals, frequency domain representation of sampling, discrete time processing of continuous time signals, continuous time processing of discrete time signals, changing the sampling rate using discrete time processing, multi rate signal processing, digital processing of analog signals, over sampling and noise shaping in A/D and D/A conversion. **08**

UNIT-III

Transform Analysis of LTI Systems: Frequency response of LTI systems, system functions, frequency response for rational system functions, magnitude-phase relationship, all pass systems, minimum phase systems, and linear systems with generalized linear phase

Overview of finite precision numerical effects, effects of coefficient quantization, effects of round-off noise in digital filters, zero-input limit cycles in fixed point realizations of IIR digital filters. **08**

UNIT-IV

Filter Design Techniques: Design of D-T IIR filters window method, optimum from continuous – time filters, design of FIR filters by windowing, Kaiser approximations of FIR filters, FIR equi-ripple approximation

Introduction to Wavelet Transform: Wavelet comparison with Fourier transforms, applications of Wavelet cosine transform, discrete cosine transform (DCT). **08**

UNIT-V

Efficient Computation of the DFT: Goertzel algorithm, decimation in time and decimation in frequency, FFT algorithm, practical considerations, implementation of the DFT using convolution, effects of finite register length.

Fourier Analysis of Signals Using DFT: DFT analysis of sinusoidal signals; Time-dependent Fourier transforms: Block convolution, Fourier analysis of non – stationary and stationary random signals, spectrum analysis of random signals using estimates of the autocorrelation sequence. **08**

Text Books:

1. S. Salivahanan, “Digital Signal Processing”, Tata McGraw Hill Publishing Co. Ltd.
2. A. V. Oppenheim, R. W. Schafer, and J. R. Buck, “Discrete Time Signal processing”, Pearson Education India.

Reference Books:

1. J. G. Proakis, and D. G. Manolakis,” Digital Signal Processing: Principles Algorithms and Applications”, Pearson Education India.
2. L. R. Rabiner, and B. Gold, “Theory and applications of DSP”, PHI Learning Pvt. Ltd.

3. A. V Oppenheim, A. S. Willsky and S. H. Nawab, “Signals and Systems”, PHI Learning Pvt. Ltd.
4. J. R. Johnson, “Introduction to Digital Signal Processing”, PHI Learning Pvt. Ltd.
5. D. J. Defatta, J. G. Lucas and W. S. Hodgkiss,” Digital Signal Processing: A System Design Approach”, John Wiley & Sons.

EE – 6055

ARTIFICIAL NEURAL NETWORKS AND FUZZY SYSTEM

L	T	P
3	0	0

UNIT-I

Neural Networks-I (Introduction & Architecture): Neuron, nerve structure and synapse, artificial neuron and its model, activation functions; Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, auto-associative and hetro-associative memory. **08**

UNIT-II

Neural Networks-II (Back propagation networks): Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propagation learning methods, effect of learning rule co-efficient; back propagation algorithm, factors affecting back propagation training, applications. **08**

UNIT-III

Fuzzy Logic-I (Introduction): Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. **08**

UNIT-IV

Fuzzy Logic –II (Fuzzy Membership, Rules): Membership functions, interference in Fuzzy logic, Fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller, Industrial applications. **08**

UNIT-V

Fuzzy Neural Networks: L-R Type Fuzzy numbers, Fuzzy neutron, Fuzzy back propagation (BP), architecture, learning in Fuzzy BP, inference by fuzzy BP, applications. **08**

Text Books:

1. Satish Kumar, “Neural Networks- A Classroom Approach”, Tata McGraw Hill Publishing Co. Ltd.
2. S. Rajasekaran and G. A. V. Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications”, PHI Learning Pvt. Ltd.
3. S. N. Sivanandam, S. Sumathi and S. N. Deepa, “Introduction to Neural Networks Using Matlab”, Tata McGraw Hill Publishing Co. Ltd.

Reference Books:

1. Siman Haykin, “Neural Networks: A Comprehensive Foundation”, PHI Learning Pvt. Ltd.
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Wiley India.