INSTITUTE OF ENGINNERING AND TECHNOLOGY LUCKNOW

(An Autonomous Constituent Institute of Dr. A.P.J. Abdul Kalam Technical University, Lucknow)

Evaluation Scheme & Syllabus

For

B. Tech. Third Year

(Electrical Engineering)

AS PER

AICTE MODEL CURRICULUM

[Effective from the Session: 2024-25]

EVALUATION SCHEME- B. TECH 3rd YEAR (ELECTRICAL ENGINEERING)
Effective from Session 2024-25

SEMESTER V													
Sr. No.	**Subject Code**	**Subject**	**Periods**			**Evaluation Scheme**				**End Semester**		**Total**	**Credit**
			L	**T**	**P**	**CT**	**TA**	**Total**	**PS**	**TE**	**PE**		
1	IEE501	Power System-I	3	1	0	20	10	30		70		100	4
2	IEE502	Control System	3	1	0	20	10	30		70		100	4
3	IEE503	Electrical Machines-II	3	1	0	20	10	30		70		100	4
4	IEE051 - IEE054	Departmental Elective-I	3	0	0	20	10	30		70		100	3
5	IEE055 - IEE058	Departmental Elective-II	3	0	0	20	10	30		70		100	3
6		Audit Course/Skill Development Course I@ (to be done in online mode)	--	--	--	--	--	--	--	--	--	--	0
7	IEE551	Power System-I Lab	0	0	2				50		50	100	1
8	IEE552	Control System Lab	0	0	2				50		50	100	1
9	IEE553	Electrical Machines-II Lab	0	0	2				50		50	100	1
10	IEE554	Mini Project or Internship Assessment*	0	0	2				100			100	1
11		MOOCs (For Hons. Degree)											
		Total	**15**	**3**	**8**							**900**	**22**

**The Mini Projector internship (4weeks) conducted during summer break after IVth semester and will be assessed during Vth semester.*
@List of Audit/Skill Development Course I for ODD Semester will be notified for respective programmes by the concerned HoD/BoS at the beginning of the semester.

Department Elective-I
IEE051: Robotics
IEE052: Sensors and Transducers
IEE053: Industrial Automation and Control
IEE054: Electrical Standards and Engineering Practices

Department Elective- II
IEE055: Optimization Techniques
IEE056: Introduction to Machine Learning
IEE057: Digital Signal Processing
IEE058: Analog & Digital Communication

SEMESTER VI													
Sr. No.	Subject Codes	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	IEE601	Power System-II	3	1	0	20	10	30	--	70	--	100	4
2	IEE602	Microprocessor and Microcontroller	3	1	0	20	10	30	--	70	--	100	4
3	IEE603	Power Electronics	3	1	0	20	10	30	--	70	--	100	4
4	IEE061-IEE064	Departmental Elective-III	3	0	0	20	10	30	--	70	--	100	3
5	IOE060-IOE069	Open Elective-I	3	0	0	20	10	30	--	70	--	100	3
6		Audit Course/Skill Development Course II@ (to be done in online mode)	--	--	--	--	--	--	--	--	--	--	0
7	IEE651	Power System-II Lab	0	0	2	--	--	--	50	--	50	100	1
8	IEE652	Microprocessor and Microcontroller Lab	0	0	2	--	--	--	50	--	50	100	1
9	IEE653	Power Electronics Lab	0	0	2	--	--	--	50	--	50	100	1
10	IEE654	Seminar/Startup	0	0	2	--	--	--	50	--	50	100	1
11		MOOCs (Essential for Hons. Degree)											
		Total	**15**	**3**	**8**							**900**	**22**

@*List of Audit/Skill Development Course II for ODD Semester will be notified for respective programmes by the concerned HoD/BoS at the beginning of the semester.*

Department Elective - III

IEE061: Special Electrical Machines

IEE062: Electrical Machine Design

IEE063: Digital Control System

IEE064: Electrical and Hybrid Vehicles

SEMESTER-V

IEE501 POWER SYSTEM-I

Pre-requisites of the course: Basic Electrical Engineering, Networks Analysis and Synthesis, Electromagnetic Field Theory.

Course Outcome		**Knowledge Level, KL**
Upon the completion of the course the student will be able to:		
CO1	Describe the working principle and basic components of conventional power plants as well as the other aspects of power generation.	**K2**
CO2	Compute performance parameters of transmission line.	**K3**
CO3	Calculate sag and tension in overhead lines and classify different type of insulators, determine potential distribution over a string of insulator.	**K3**
CO4	Compute transmission line parameters for various configurations.	**K3**
CO5	Calculate the resistance and capacitance parameters of cables, grading of cables and compare it with overhead lines.	**K3**

KL-Bloom's Knowledge Level K1–Remember, K2–Understand, K3–Apply, K4–Analyze, K5–Evaluate, K6–Create

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE501.C1	3	2											2	2
IEE501.C2	3	2	1	2	1								2	2
IEE501.C3	3	3	1	2	2								2	2
IEE501.C4	3	3	1	2	2								2	2
IEE501.C5	3	3	1	2	2								2	2

Detailed Syllabus:

UNIT-I: Power System Generation

Introduction: Basic structure of power system, Single line diagram of Power system,

Sources of electric energy: conventional and non- conventional; Layout of Hydro-electric, Thermal and Nuclear power plants, Concept of cogeneration, combined heat and power, and captive power plants.

Load curve, load duration curve, Concept of Connected Load, Maximum Demand, Average load, Demand Factor, Load factor, Diversity Factor, Capacity Factor, Utilization factor, Plant use factor, Installed capacity, Reserves, role of load diversity in power system economy. Load Sharing between Base load and Peak Load.

UNIT-II: Transmission & Distribution of Electric Power-I

Configurations of transmission lines: Types of conductors, Bundled Conductors, resistance of line, skin effect, Kelvin's law, Proximity effect, Corona Effect**,** Factors affecting the Corona, Corona Power Loss, Advantages and Disadvantages.

Transmission Line Parameters: Inductance and Capacitance Calculations of Transmission Lines: Line conductors, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, Composite conductors-transposition, bundled conductors, and effect of earth on capacitance.

UNIT-III: Performance of Transmission Lines

Per Unit System, Representation of lines: short transmission lines, medium length lines, nominal T and л-representations, long transmission lines. The equivalent circuit representation of a long Line, A,B,C,D constants, Ferranti Effect, Tuned power Lines. Introduction to Reactive Power

Compensation- shunt and series compensation.

UNIT-IV: Transmission & Distribution of Electric Power-II

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

Insulated Cables: Introduction, insulation, insulating materials, Extra high voltage cables, grading of cables, insulation resistance of a cable, Capacitance of a single core and three core cables, Overhead lines versus underground cables, types of cables.

UNIT-V: Mechanical and Electrical Design of Overhead lines

Mechanical Design of Over Headlines: Catenary curve, calculation of sag & tension, effects of wind and ice loading, sag template, vibration dampers.

Electrical Design of Over Headlines: choice of transmission voltage, Different kinds of supply system and their comparison. Substation and its type. Introduction to Busbar system and connection schemes

System earthing: basic concept and types of earthing

Textbooks:

1. Kothari & Nagrath,"Power System Engineering", Tata McGraw-Hill Education
2. Deshpande M. V, `Elements of Electrical Power systems Design', Pitman, New Delhi, PHI Learning Private Limited,
3. Chakrabarti A., Soni M.L., Gupta P.V., and Bhatnagar U.S., 'A textbook on Power Systems Engg.', Dhanpat Rai and Sons, New Delhi.
4. C. L. Wadhwa, "Electrical Power System", New age international Ltd. Third Edition.
5. Arun Ingole, "Power Transmission and Distribution", Pearson India Ltd.

Reference Books:

1. Wadhwa, C.L., 'Generation Distribution and Utilization of Electrical Energy', New Age International publishers.
2. S. N. Singh, "Electric Power Generation Transmission & Distribution", PHI Learning.
3. A. J. Wood & B.F. Wollenburg, "Power Generation, Operation and Control "John Wiley & Sons.

IEE502 **CONTROL SYSTEM**

Course Outcomes Statement:

CO Statement	COs	*KL/BL*
Obtain transfer functions to predict the correct operation of open loop and closed loop control systems and identify the basic elements, structures and the characteristics of feedback control systems.	**CO1**	**K3**
Measure and evaluate the performance of basic control systems in time domain.	**CO2**	**K3**
Analyze the stability of linear time-invariant systems in time domain using Routh-Hurwitz criterion and root locus technique.	**CO3**	**K4**
Determine the stability of linear time-invariant systems in frequency domain using Nyquist criterion and Bode plot.	**CO4**	**K3**
Design different type of compensators to achieve the desired performance of control System by root locus and Bode plot method. Develop and analyze the various types of controllers.	**CO5**	**K3**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE502.C1	3	3		2		3							2	1
IEE502.C2	3	3	3	2	3	1							1	2
IEE502.C3	3	3	3	3	2	3							2	2
IEE502.C4	3	2	1	3	3	3							2	3
IEE502.C5	2	3	3	3	1	3							2	3

Syllabus	**Contact Hours**
Unit-1	**8**
Control System Concepts: Elements of control systems, concept of open loop and closed loop systems, Examples and application of open loop and closed loop systems, Determination of transfer function by block diagram reduction techniques and signal flow method using Mason's gain formula, Basic Characteristics of negative feedback control systems. **Control System Components:** Constructional and working concept of AC & DC servomotor, synchros.	
Unit-2	**8**
Time Response Analysis: Standard test signals, time response analysis of first and second order systems, time response specifications of second order system for unit step & unit ramp input, location of roots of characteristics equation and corresponding time response, steady state errors and error constants.	
Unit-3	**8**
Stability and Algebraic Criteria: Concept of stability and its necessary conditions, Routh-Hurwitz criteria and its special cases & limitations. **Root Locus Technique:** Salient features & procedure of plotting root locus plot, root contours, determination of stability of a closed loop system using root locus technique.	
Unit-4	**8**
Frequency Response Analysis: Frequency Response analysis from transfer function model, Construction of polar and inverse polar plots. **Stability in Frequency Domain:** Nyquist stability criterion, Determination of gain and phase margin from Bode & Nyquist Plots, Correlation between time and Frequency Responses.	
Unit-5	**8**
Introduction to Design: The design problems and preliminary considerations of lead, lag and lead-lag compensation networks, design of closed loop systems using compensation techniques	

in time and frequency domains. Basic modes of feedback control: Proportional, Derivative, Integral, PID & Industrial controllers	

Reference/Text Books

1. Joseph J. Distefano III, Allen R. Stubberud, Ivan J. Williams, "Control Systems" (Schaums Outlines Series), 3rd Edition, McGraw Hill, Special Indian Edition, 2010.
2. Norman S. Mise, Control System Engineering, Wiley Publishing Co.
3. M. Gopal, Control Systems Engineering, New Age International Publishers.
4. R. T. Stefani, B. Shahian, C. J. Savant and G.H. Hostetter, "Design of Feedback Control Systems" Oxford University Press.
5. A. K. Jairath, Problems and Solutions of Control Systems: With Essential Theory (CBS Problems and Solutions Series).

IEE503 **ELECTRICAL MACHINE-II**

Pre-requisites of course: Basic Electrical Engineering, Electrical Machine-I

Course Outcomes Statement:

CO Statement	COs	*KL/BL*
Describe the constructional details and principle of operation of three phase synchronous machines.	**CO1**	**K2**
Illustrate the performance characteristics of the three phase synchronous machines using the phasor diagrams and equivalent circuits.	**CO2**	**K4**
Describe the constructional details and principle of operation of three phase induction.	**CO3**	**K4**
Illustrate the performance characteristics of the three phase induction machines using the phasor diagrams and equivalent circuits.	**CO4**	**K4**
Explain the principle of operation and performance of single-phase induction motor & universal motor.	**CO5**	**K3**

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create.

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE503.CO1	3	3	2										2	2
IEE503.CO2	3	3	2										2	2
IEE503.CO3	3	3	2										2	2
IEE503.CO4	3	3	2										2	2
IEE503.CO5	3	3	2										2	2

Syllabus	**Contact Hours**
Unit-1: Synchronous Machine I	**8**
Constructional features, Armature winding, EMF Equation, Winding coefficients, Equivalent circuit and phasor diagram, Armature reaction, O. C. & S. C. tests, Voltage regulation using Synchronous Impedance method, MMF method, Potier's Triangle method, Parallel operation of synchronous generators (Conditions, load sharing).	
Unit-2: Synchronous Machine II	**8**
Power flow equations of cylindrical and salient pole machines, Operating characteristics. Synchronous Motor - Starting methods, Effect of varying field current at different loads, V- curves, Hunting & damping, Synchronous condenser, application of synchronous motor.	
Unit-3: Three phase Induction Machine – I	**8**
Constructional features, Rotating magnetic field, Principle of operation, Phasor diagram, Equivalent circuit, and Torque and power equations, Torque- slip characteristics, No load & blocked rotor tests, Efficiency.	
Unit-4: Three phase Induction Machine - II	**8**
Starting, Deep bar and double cage rotors, Cogging & Crawling, Speed control (with and without emf injection in rotor circuit), Induction generator, applications.	
Unit-5: Single phase Induction Motor	**8**
Double revolving field theory, Equivalent circuits, No load and blocked rotor tests, Starting methods, Types of single phase induction motors, Repulsion motor, Universal motor, hysteresis motor.	

Text Books:

1. I. J. Nagrath & D.P. Kothari, "Electrical Machines", McGraw Hill
2. Rajendra Prasad, "Electrical Machines", PHI
3. PS Bimbhra, "Electrical Machinery", Khanna Publisher
4. AE Fitggerald, C. Kingsley Jr and Umans, "Electric Machinery", McGraw Hill, International Student Edition.

Reference Books:

1. H. Cotton, "Electrical Technology", CBS Publication.
2. MG Say, "The Performance and Design of AC machines", Pit man& Sons.
3. PS Bimbhra, "Generalized Theory.
4. Samarjit Ghosh, " Electrical Machines", Pearson Education

IEE551 **POWER SYSTEM-I LAB**

Pre-requisites of course: Basic understanding of Scilab/MATLAB/C/C++

CO Statement	COs	*KL/BL*
Analyze effect of configuration of single phase and three phase transmission lines on their parameters (L and C).	**CO1**	**K4**
Calculate ABCD parameters of nominal pi and T networks.	**CO2**	**K3**
Analyze Ferranti effect by simulating it.	**CO3**	**K4**
Demonstrate effect of various parameters on corona loss and calculate string efficiency by writing a program.	**CO4**	**K3**
Calculate sag, tension, and ground clearance of transmission lines by writing a program.	**CO5**	**K3**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE551.C1	3	2	1		2			1					1	1
IEE551.C2	3	2	2	1	2			1					1	1
IEE551.C3	3	2	2		2			1					1	1
IEE551.C4	3	2	1		2			1					1	1
IEE551.C5	3	2	1		2			1					1	1

List of Experiments:

1. Calculate the parameters of single-phase transmission line
2. Calculate the parameters of three phase single circuit transmission line
3. Calculate the parameters of three phase double circuit transmission line
4. Determine the ABCD constant for transmission line.
5. Simulate the Ferranti effect in transmission line
6. Calculate the corona loss of transmission line
7. Calculation of sag & tension of transmission line
8. Calculation of string efficiency of insulator of transmission line
9. Calculation for grading of underground cables
10. Simulate the skin effect in the transmission line
11. Calculation of ground clearance of transmission line
12. Calculate the parameters for underground cable.

Spoken Tutorial (MOOCs):

Spoken Tutorial MOOCs, ' Course on Scilab', IIT Bombay (http://spoken-tutorial.org/)

IEE552 CONTROL SYSTEM LAB

Pre-requisites of course: Basic understanding of Scilab/MATLAB or any equivalent open-source software

CO Statement	COs	*KL/BL*
Determine the characteristics of control system components like synchro Transmitter and receiver, RTD, potentiometer and use them in error detector mode.	**CO1**	**K3**
Compare the performance of control systems by applying different controllers and compensators.	**CO2**	**K5**
Analyse the behaviour of dc motor in open loop and closed loop conditions at various loads & concept of the response of 1st & 2nd order systems for various values of constant K.	**CO3**	**K4**
Analyse the stability of different control systems by applying different stability methods of time & frequency domain in control systems using software	**CO4**	**K4**
Convert the transfer function into state space & vice versa & obtain the time domain response of a second order system for step input and their performance parameters using software.	**CO5**	**K3**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE552.C1	2	1	1	2					2				1	1
IEE552.C2	2	1	1	2					2				1	1
IEE552.C3	2	1	1	2					2				1	1
IEE552.C4	2	1	1	1	2				2				1	1
IEE552.C5	2	1	1	1	2				2				1	1

List of Experiments:	Contact Hours
1. To study phase Lag and Lead network and draw its frequency response.	2
2. To study Synchro Transmitter characteristics and obtain output vs input characteristics.	2
3. 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
4. To study characteristics of positional error detector by angular displacement of two servo potentiometers.	2
5. To simulate and compare the response of 2nd order system with and without lead, lag, Lead- Lag compensator / simulate PID controller for transportation lag.	2
6. To study P, PI and PID temperature controller for an oven and compare their characteristics.	2
7. To study and calibrate temperature using resistance temperature detector (RTD).	2
8. To study behaviour of separately excited dc motor in open loop and closed loop conditions at various loads.	2
Software based experiments (Scilab/MATLAB or any equivalent open source software)	
9. To determine time domain response of a second order system for step input and obtain performance parameters.	2
10. To convert transfer function of a system into state space form and vice-versa.	2
11. To plot root locus diagram of an open loop transfer function and determine range of gain 'k' for stability.	2
12. To plot a Bode diagram of an open loop transfer function.	2
13. To draw a Nyquist plot of an open loop transfers functions and examine the stability of the closed loop system.	2

Spoken Tutorial (MOOCs):

Spoken Tutorial MOOCs, ' Course on Scilab', IIT Bombay (http://spoken-tutorial.org/)

Reference Books:

1. K. Ogata, "Modern Control Engineering" Prentice Hall of India.
2. Norman S. Nise, "Control System Engineering", John Wiley & Sons.
3. M. Gopal, "Control Systems: Principles & Design" Tata McGraw Hill.

IEE553 ELECTRICAL MACHINES-II LAB

Pre-requisites of course: Basic Electrical Engineering Lab**,** Electrical Machine-I Lab.

Course Outcome Statements:

CO Statement	COs	*KL/BL*
Perform various tests and demonstrate the characteristics of three-phase synchronous machine.	**CO1**	**K3**
Perform various tests and demonstrate the characteristics of three-phase induction motor.	**CO2**	**K3**
Analyze the performance of three-phase induction motor.	**CO3**	**K4**
Analyze the performance of single-phase induction motor.	**CO4**	**K4**
Investigate simulation models for Electrical Machines.	**CO5**	**K4**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE553.C1	2	2	2	1	1				1			1	1	1
IEE553.C1	2	2	2	1	1				1			1	1	1
IEE553.C1	2	2	2	1	1				1			1	1	1
IEE553.C1	2	2	2	1	1				1			1	1	1
IEE553.C1	2	2	2	1	1				1			1	1	1

Note: Minimum 10 experiments are to be performed from the following list:

1. To perform open circuit and short circuit tests on a three phase alternator.
2. To draw O.C. and S.C. characteristics of a three phase alternator from the experimental data and determine voltage regulation at full load, and unity, 0.8 lagging and leading power factors.
3. Load Test on Three Phase Alternator.
4. To study synchronization of an alternator with the infinite bus by using: (i) dark lamp method (ii) two bright and one dark lamp method.
5. To determine the direct axis reactance (Xd) and quadrature axis reactance (Xq) of synchronous machine.
6. To determine V-curves and inverted V-curves of a three phase synchronous motor.
7. To perform no-load and blocked-rotor tests on a three-phase squirrel cage induction motor and determine equivalent circuit.
8. To perform load test on a three phase induction motor and draw Torque -speed characteristics
9. To determine steady state performance of a three phase induction motor using equivalent circuit.
10. To perform the speed control test on slip ring induction motor by rotor resistance control method. Plot the motor speed characteristics at different values of applied resistance in slip ring of induction motor.
11. To perform no-load and blocked rotor tests on a single-phase induction motor and determine equivalent circuit.
12. To determine speed-torque characteristics of single phase induction motor and study the effect of voltage variation.

***The available experiments from above list may be performed on virtual lab on following virtual lab link: http://vlab.co.in/**

Reference/Text Books

Text Books:

1. I J Nagrath & D.P. Kothari, "Electrical Machines", Tata McGraw Hill
2. Rajendra Prasad, "Electrical Machines", PHI
3. PS Bimbhra, "Electrical Machinery", Khanna Publisher
4. AE Fitggerald, C. Kingsley Jr and Umans, "Electric Machinery", McGraw Hill, International Student Edition.

Reference Books:

1. H. Cotton, "Electrical Technology", CBS Publication.
2. MG Say, "The Performance and Design of AC machines", Pit man& Sons.
3. PS Bimbhra, " Generalized Theory of Electrical Machines”.

IEE554 **Mini Project or Internship Assessment**

Course Outcomes:		**Knowledge Level, KL**
Upon the completion of the course, the student will be able:		
CO1	Project Planning & Proposal development **--** To **formulate** and **justify** clear, feasible project objectives and proposals by **analysing** and **synthesizing** relevant literature and background information.	**Evaluate**
CO2	Social relevance of project – To **analyze** the impact of developed solutions in societal and environmental contexts, **demonstrate** the knowledge of, and need for sustainable development.	**Analyze**
CO3	Data Collection & Analytical Skill -- To **collect** accurate data proficiently and **performing** thorough and correct analysis to **evaluate** and **interpret** data for meaningful insights and conclusions.	**Evaluate**
CO4	Outcome (Development of Solution & modern tool) -- Assess the outcome of the internship/mini project/industrial training/Internship/Seminar in form of some, project proposal, term paper, programming codes or app development based on the study.	**Evaluate**
CO5	Oral Presentation & Communication Skill— To **deliver** clear and organized oral presentations and **respond** confidently to questions to demonstrate effective communication skills.	**Apply**

KL-Bloom's Knowledge Level (K_1,K_2,K_3,K_4,K_5,K_6)

K_1– Remember, K_2 –Understand, K_3–Apply, K_4– Analyze, K_5– Evaluate, K_6– Create.

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE554.C1	3								2			2	1	1
IEE554.C2		3			2		2		2	3			1	1
IEE554.C3		2		3	2	2	2	3	2	3	3	2	1	1
IEE554.C4			3		2	2	2		2		2		1	1
IEE554.C5								3	3	3	2	3	1	1

SEMESTER-VI

IEE601 **POWER SYSTEM-II**

Pre-requisites of course: Basic Electrical Engineering, Networks Analysis and Synthesis, Electromagnetic Field Theory, Power System-I, Electrical Machines-II.

Course Outcomes Statement:

CO Statement	COs	*KL/BL*
Compute the network parameters under both balanced and unbalanced fault conditions and calculate the ratings of circuit breakers.	**CO1**	**K3**
Perform load flow analysis of an electrical power network and interpret the results of the analysis.	**CO2**	**K3**
Determine the over voltage caused by surge propagation in transmission networks by applying the travelling wave theory.	**CO3**	**K3**
Assess the steady state and transient stability of the power system under various conditions.	**CO4**	**K4**
Describe Operating Principle of a relay and Circuit breaker, classify them according to applications.	**CO5**	**K2**

Syllabus	Contact Hours
Unit-1: Fault Analysis in Power System	**8**
Symmetrical Components: Significance of positive, negative and zero sequence components, Average 3- phase power in terms of symmetrical components, sequence impedances and sequence networks. **Fault Calculations:** Fault calculations, sequence network equations, single line to ground fault, line to line fault, double line to ground fault, three phase faults, faults on power systems, and faults with fault impedance, reactors and their location, short circuit capacity of a bus.	
Unit-2: Load Flow Analysis	**8**
Introduction, Formation of ZBUS and YBUS, development of load flow equations, load flow solution using Gauss Siedel and Newton-Raphson method, Comparison of Gauss Siedel and Newton Raphson Method, approximation to N-R method, fast decoupled method.	
Unit-3: Travelling Waves in Power System	**8**
Travelling Waves on Transmission Lines: Production of travelling waves, open circuited line, short circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at T-junction line terminated through a capacitance, capacitor connection at a T-junction, at a two substation system, Attenuation of travelling waves, Bewley's Lattice diagram.	
Unit-4: Stability in Power System	**8**
Power flow through a transmission line, Stability and Stability limit, Steady state stability study, derivation of Swing equation, transient stability studies by equal area criterion. Factors affecting steady state and transient stability and methods of improvement.	
Unit-5: Introduction to Power System Protection	**8**
Relays: Operating Principle of a general relay, Basic Terminology: Relay, Energizing Quantity, setting, Pickup, drop out, Flag, fault clearing time, Relay time, Breaker time, Overreach, Underreach; Classification of Relays according to applications, according to time. Overcurrent Relay, Distance Protection, Differential Protection, Numerical protection **Circuit Breakers:** Arc Phenomenon, Arc Extinction and its Methods, Restriking Voltage & Recovery Voltage, Circuit Breaker Rating	

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE601.CO1	3	2	2	1										
IEE601.CO2	3	2	1	1										
IEE601.CO3	3	2	1											
IEE601.CO4	3	2	2	1										
IEE601.CO5	2	2												

Reference/Text Books

<u>Text Books:</u>

1. D.P. Kothari & I.J. Nagrath, “Modern Power System Analysis” Tata McGraw Hill, 3rd Edition.
2. P.S.R. Murthy, “Operation and controlling Power Systems” B.S. Publications.
3. W.D. Stevenson, “Elements of Power System Analysis”, McGraw Hill
4. J. Wood & B.F. Wollenburg, “Power Generation, Operation and Control “John Wiley & Sons.
5. S. S. Rao, “Switchgear and Protection”, Khanna Publishers.
6. B. Ravindranath and M. Chander, Power system Protection and Switchgear, Wiley Eastern Ltd.

Reference Books:

1. O.I. Elgerd, “Electric Energy System Theory” Tata Mc Graw Hill.
2. P. Kundur, “Power System Stability and Control” McGraw Hill.
3. T.K. Nagsarka & M.S. Sukhija, “Power System Analysis’ Oxford University Press.
4. Hadi Sadat, “Power System Analysis”, Tata McGraw Hill.
5. B. Ram and D.N. Vishwakarma, “Power System Protection and Switchgear”, Tata Mc. Graw Hill

IEE602 MICROPROCESSOR AND MICROCONTROLLER

Pre-requisites of course: Digital Electronics, Computer Basics.

Course Outcomes Statement:

CO Statement	COs	*KL/BL*
Demonstrate the basic architecture of 8085 & 8086 microprocessors.	**CO1**	**K2**
Illustrate the programming model of microprocessors & write program using 8085 Microprocessor.	**CO2**	**K3**
Interface different external peripheral devices with 8085 microprocessor.	**CO3**	**K3**
Comprehend the architecture of 8051 microcontroller.	**CO4**	**K2**
Compare advance level microprocessor & microcontroller for different Applications.	**CO5**	**K4**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE602.C1	3		2	1		2	1							
IEE602.C2	3		2	1		2	1					1		
IEE602.C3	3		2	1		2	1					1		
IEE602.C4	3		2	1		2	1					1		
IEE602.C5	3		2	1		2	1							

Syllabus	**Contact Hours**
Unit-1:	**8**
Types of Microprocessor Architecture: Harward & Princeton. **Intel 8085 microprocessor:** Internal architecture (ALU, System bus, Registers, Timing & control unit, Address/data bus de-multiplexing). **Intel 8086 microprocessor:** Internal architecture, Pin Diagram, Memory Addressing, Interrupts.	
Unit-2:	**8**
Fundamental of Programming: Program structure & programming techniques for microprocessors, 8085 Addressing modes, 8085 Instruction set, Assembly language programming of 8085 microprocessor with examples (arithmetic operations on 8-bit numbers – add, subtract, multiply, divide, square & square root etc, largest/ smallest number; ascending/ descending order).	
Unit-3:	**8**
I/O Interface: 8255 PPI, architecture, various modes of operation & control words, interfacing of 8255. **Interfacing with I/O devices:** Keyboard, display, stepper motor, D/A & A/D converter **Serial communication standards:** Serial data transfer schemes, 8251 USART architecture & interfacing.	
Unit-4:	**8**
Introduction to microcontrollers: 8051 microcontroller - internal architecture, signals, I/O ports, memory organization & interfacing, timing and control, port operations.	
Unit-5:	**8**
8051 Real Time Control: 8051 timers and counters, interrupts in 8051. Comparison of Microprocessor, Microcontroller, PIC and ARM processors and their application areas.	

Reference/Text Books

1. Brey, Barry B. “INTEL Microprocessors” Prentice Hall (India).
2. Aditya P Mathur, “Introduction to Microprocessor” Tata McGraw Hill.
3. M. Rafiquzzaman, “Microprocessors- Theory & applications”, Pearson India.
4. B. Ram, “Advanced Microprocessor & Interfacing” Tata McGraw Hill.
5. Liu and Gibson G.A., “Microcomputer Systems: The 8086/8088 Family Architecture Programming & Design” Pearson India.

6. Microprocessors and microcontrollers - N. Senthil Kumar, M. Saravanan and Jeevananthan (Oxford university press).
7. Gaonkar, Ramesh S, “Microprocessor Architecture, programming and applications with the 8085” Pen ram International Publishing 5th Ed.
8. Avtar Singh & Walter A. Triebel “8088 & 8086 Microprocessor” Pearson Education.
9. Ray, A.K. & Burchandi, K.M., “Advanced Microprocessors and Peripherals: Architecture, Programaming and Interfacing” Tata Mc. Graw Hill.
10. AK Gautam, “Advanced Microprocessors”, Khanna Publishers.
11. 8051 Microcontroller – K. Ayala (Cengage learning).

IEE603: POWER ELECTRONICS

Pre-requisites of course: Basic Electrical Engineering, Network Analysis & Synthesis.

Course Outcomes:		**Knowledge Level, KL**
Upon the completion of the course, the student will be able to:		
CO1	Demonstrate the characteristics as well as the operation of BJT, MOSFET, IGBT, SCR, TRIAC and GTO and identify their use in the power switching applications.	**K4**
CO2	Comprehend the non-isolated DC-DC converters and apply their use in different Power electronics applications.	**K3**
CO3	Analyze the phase controlled rectifiers and evaluate their performance parameters.	**K4**
CO4	Apprehend the working of single-phase ac voltage controllers, cyclo-converters And their various applications.	**K3**
CO5	Explain the single-phase and three phase bridge inverters differentiate between CSI and VSI and apply PWM for harmonic reduction.	**K3**

KL-Bloom's Knowledge Level (K_1,K_2,K_3,K_4,K_5,K_6)
K_1–Remember, K_2–Understand, K_3–Apply, K_4–Analyze, K_5–Evaluate, K_6–Create.

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
IEE603.CO1	3	2										1
IEE603.CO2	3	2	1	2	1							1
IEE603.CO3	3	3	1	2	2							1
IEE603.CO4	3	3	1	2	2							1
IEE603.CO5	3	3	1	2	2							1

Detailed Syllabus:

Unit-I: Power semiconductor devices:
Introduction: Concept of Power Electronics, scope and applications, desired Characteristics of controllable switches.
Power semiconductor switches, their characteristics, principle of operation, and Specific applications: Power Diode, Power BJT, Power MOSFET, IGBT, SCR, TRIAC, GTO, Silicon carbide semiconductors.

Unit-II:
Thyristor: Rating & protection, Methods of SCR commutation, Gate Drive Circuit, Series and Parallel operation.
AC Voltage Controllers: Principle of On-Off and phase controls, Single phase ac voltage controller with resistive and inductive loads, sequence control, Introduction to Cyclo converters

Unit-III: Phase Controlled Converters

Single phase half wave controlled rectifier with various loads, Effect of freewheeling diode, Single phase fully controlled and half controlled bridge converters with various loads. Power factor, Distortion Factor & other Performance Parameters of single phase uncontrolled and controlled converters, 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.

Unit-IV:

DC-DC switched mode Converters: Introduction, Control Strategies, Buck converter, Boost Converter, Buck-Boost converter, Analysis of buck converter, Switched Mode power Supply (SMPS).

DC-AC switched mode converters, resonant converters, high frequency inductors and transformers, power supplies.

Unit-V: Inverters

Single phase and Three phase bridge inverters, voltage source inverters, current source inverters, Voltage control of single-phase inverters, Pulse width modulation, Sinusoidal PWM, Introduction to Multi level inverter.

Text Books:

1. M.H. Rashid, "Power Electronics: Circuits, Devices & Applications", Prentice Hall of India Ltd. 3rd Edition, 2004.
2. Ned Mohan, T.M. Undeland and W.P. Robbins, "Power Electronics: Converters, Applications And Design", Wiley India Ltd, 2008.
3. P.C. Sen, "Power Electronics", McGraw Hill Education (India) Pvt. Ltd.
4. P.S. Bhimbra, "Power Electronics", Khanna Publishers.
5. D.W. Hart "Power Electronics", McGraw Hill Education.
6. R. Samshaw "Power Electronics Semiconductor Switches" Springer Science Media, B.V.

Reference Books:

1. M.S. Jamil Asghar, "Power Electronics" Prentice Hall of India Ltd., 2004.
2. Chakrabarti & Rai, "Fundamentals of Power Electronics & Drives" Dhanpat Rai & Sons.
3. V. R. Moorthy, "Power Electronics: Devices, Circuits and Industrial Applications" Oxford University Press, 2007.
4. S. N. Singh, "A Text Book of Power Electronics" Dhanpat Rai & Sons.

IEE651: POWER SYSTEM-II LAB

Pre-requisites of course: Power System-I Lab.

Course Outcomes:		**Knowledge Level, KL**
Upon the completion of the course, the student will be able to:		
CO1	Test various relays for different characteristics and compare with the performance characteristics provided by manufacturers.	**K4**
CO2	Select the power system data for load-flow and fault studies and to write a Program to solve power flow problem using NR and GS methods.	**K5**
CO3	Analyze various types of short circuit faults.	**K4**
CO4	Demonstrate different numerical integration methods and factors influencing transient stability.	**K3**
CO5	Determine the effect of loading long transmission line.	**K3**

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
KEE651.C1	3	3	2	1	2				2			
KEE651.C2	3	3	2	1	1				2			
KEE651.C3	3	3	2	1	2				2			
KEE651.C4	3	3	2	1	2				2			
KEE651.C5	3	3	2	1	2				2			

Note: Minimum 10 experiments are to be performed from the following list:

(A) Hardware Based Experiments:

1. 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.
2. To Study the over-current relay and the effect of PSM and TSM.
3. To study percentage differential relay.
4. To study Impedance, MHO and Reactance type distance relays and zones of protection.
5. To study Ferranti effect of a transmission line/cable.
6. To measure the dielectric Strength of transformer oil.
7. To study the Synchronization of alternator within finite bus bar.
8. To determine positive sequence, negative sequence and zero sequence reactance of an alternator.
9. To Study the effect of different shape of electrodes on dielectric (air) breakdown.
10. To Study the gas actuated Buchholz relay for oil filled transformer.
11. To determine the sub-transient (xd″), transient (xd′) and steady state reactance (xd) of a synchronous machine.

*** The available Experiments from above list may be performed on virtual lab on following virtual lab link: http://vlab.co.in/**

(B) Simulation Based Experiments (using Scilab/MATLAB or any other equivalent open source software platform).

1. To obtain formation of Y-bus.
2. Perform load flow analysis on a 3-Bus System using G-S Method.
3. Perform load flow analysis on a 3-Bus System using N-R Method.
4. To perform symmetrical fault analysis in a power system.
5. To perform unsymmetrical fault analysis in a power system.
6. Swing Curve by Step-by-Step Method.
7. Determination of the stability of a SMIB system in occurrence of a fault by solving the Swing equation by Euler's Method.

Text Books:-

1. Haadi Sadat, "Power System Analysis" Tata McGraw Hill.
2. T.K. Nagsarskar & M.S. Sukhija, Power System Analysis' Oxford University Press.
3. K. Umarao, "Computer Techniques and Models in Power System", Wiley.

IEE652 MICROPROCESSOR AND MICROCONTROLLER LAB

Pre-requisites of course: Digital Electronics, Computer Basics.

Course Outcomes:		**Knowledge Level, KL**
Upon the completion of the course, the student will be able to:		
CO1	Describe the microprocessor system.	K2
CO2	Develop a flow chart for understanding the data flow.	K3
CO3	Apply assembly language programming to program microprocessor-based system.	K3
CO4	Interface different peripheral devices with the microprocessor.	K4
CO5	Build logic for microprocessor-based system.	K4

KL-Bloom's Knowledge Level (K_1,K_2,K_3,K_4,K_5,K_6).
K_1–Remember, K_2–Understand, K_3–Apply, K_4–Analyze, K_5–Evaluate, K_6–Create.

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
IEE652.C1	3		2	1		2	1					
IEE652.C2	3		2	1		2	1					1
IEE652.C3	3		2	1		2	1					1
IEE652.C4	3		2	1		2	1					1
IEE652.C5	3		2	1		2	1					

Note: Minimum ten experiments are to be performed from the following list (on 8085/8086 microprocessor)

List of Experiments:

1. To study 8085/8086 based microprocessor system.
2. To perform mathematical operations (addition & subtraction) on two 8-bit numbers.
3. To perform multiplication on two 8-bit numbers.
4. To perform division on two 8-bit numbers.
5. To develop and run a program for finding out the largest number from given two 8-bit numbers.
6. To develop and run a program for finding out the smallest number from given two 8-bit numbers.
7. To develop and run a program for arranging in ascending order of a given set of 8-bit numbers.
8. To develop and run a program for arranging in descending order of a given set of 8-bit numbers.
9. To perform conversion of temperature from degree F to degree C.
10. To perform computation of square root of a given number.

11. To obtain interfacing of 8255–PPI with 8085 microprocessor.
12. To perform microprocessor based traffic light control.
13. To perform microprocessor based stepper motor operation through 8085/8086 kit.
14. To obtain interfacing of DMA controller with 8085/8086 microprocessor.

IEE653 **POWER ELECTRONICS LAB**

Pre-requisites of course: Basic Electrical Engineering, Network Analysis & Synthesis.

Course Outcomes:		**Knowledge Level, KL**
Upon the completion of the course, the student will be able to:		
CO 1	Demonstrate the characteristics and triggering of IGBT, MOSFET, Power transistor and SCR.	**K3**
CO2	Analyze the performance of single phase fully controlled bridge rectifiers under different loading conditions.	**K4**
CO3	Develop simulation models of power electronic circuits.	**K5**

KL-Bloom's Knowledge Level (K1,K2,K3,K4,K5,K6)
K1–Remember, K2–Understand, K3–Apply, K4–Analyze, K5–Evaluate, K6–Create.

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
KEE653.C1	3	2			2			1				
KEE653.C2	3	2	2	1	2			1				
KEE653.C3	3	2	3		2			1				

Experiment List	**Contact Hours**
1- Study Gate Pulse Generation using R, RC and UJT.	**2**
2- To study Characteristics of SCR and TRIAC.	**2**
3- To study Characteristics of MOSFET and IGBT.	**2**
4- To study IGBT based single phase PWM inverter.	**2**
5- To study IGBT based three phase PWM inverter.	**2**
6- To study Characteristics of GTO.	**2**
7- To study single phase fully controlled bridge rectifiers with resistive and inductive loads.	**2**
8- Simulation of PE circuits (1Φ&3Φsemiconverter, 1Φ & 3Φ full converter, DC-DC converters, AC voltage controllers).	**2**
9- To study Speed control of PMDC motor using MOSFET.	**2**
10- To study Single Phase series inverter with R load.	**2**
11- To study Single Phase Cycloconverters with R load.	**2**
12- To study Single Phase AC Voltage Controller with R Load.	**2**
13- To study Three Phase half controlled bridge converter with R-load.	**2**
14- To study Single Phase fully controlled bridge converter with R and RL loads.	**2**

Software based experiments (Sci lab/MATLAB or any equivalent open source software)

- To obtain the simulation of single-phase half wave-controlled rectifier with R and RL load and plot load voltage and load current waveforms.
- To obtain simulation of single phase fully controlled bridge rectifier and plot load voltage and load current waveform for inductive load.
- To obtain simulation of single phase full wave voltage controller and draw load voltage and load current waveforms for inductive load.
- To obtain simulation of step down chopper with L-C output filter for inductive load and determine steady-state values of output voltage ripples in output voltage and load current.

DEPARTMENT ELECTIVE-I

IEE051 **ROBOTICS**

Pre-requisites of course: Basic Mathematics.

Course Outcomes Statement:

CO Statement	COs	*KL/BL*
Describe the basic terminology used in robotics.	**CO1**	**K2**
Explain 3-D translation & orientation of robot arm kinematics.	**CO2**	**K2**
Describe different robotic actuators and power transmission systems.	**CO3**	**K2**
Classify the types of robotic grippers used in automation industries.	**CO4**	**K2**
Describe robotic sensor IC system and their interfacing with robot controller.	**CO5**	**K2**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE051.C1	2	2	1	1	1								1	1
IEE051.C2	2	2	1	1	1								1	1
IEE051.C3	2	2	1	1	1								1	1
IEE051.C4	2	2	1	1	1								1	1
IEE051.C5	2	2	1	1	1								1	1

Syllabus	Contact Hours
UNIT I	**8**
INTRODUCTION: Introduction to robotics, Evolution of Robotics, Classifications and specifications of robots, Flexible automation vs. Robotic technology, Robot components and degree of freedom, Robot joints, coordinates and reference frames, characteristics of robots, Robot workspace, role of robots in Industry 4.0, Robot safety and social robotics.	
UNIT II	**8**
KINEMATICS OF ROBOT: Matrix representation of robot kinematics, Transformation of matrix, Forward and Inverse Kinematics of robots, D-H Representation of Six Degree of Freedom Robot Arm.	
UNIT III	**8**
ROBOT ACTUATORS AND POWER TRANSMISSION SYSTEMS: Characteristics of actuating systems, comparison of hydraulic, pneumatic and electrical actuating system, Mechanical transmission method (concept only) - Gear transmission, Belt drives, cables, Roller chains, Link Rod systems, Rotary-to-Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearing screws.	
UNIT IV	**8**
ROBOT GRIPPERS: Classification of End effectors, Drive system for grippers **-** Mechanical adhesive vacuum-magnetic-grippers. Hooks & scoops, Active and passive grippers.	
UNIT-V	**8**
ROBOT SENSORS, CONTROL HARDWARE AND INTERFACING: Sensor: Contact & Proximity, Position, Velocity, Force and Tactile, Introduction to Cameras, Vision applications in robotics; integration of robot controller with sensors, actuators & other supporting components.	

TEXT BOOKS:

1. Saeed B. Niku, “Introduction to Robotics”, Pearson, 2011.
2. Deb S. R. and Deb S., “Robotics Technology and Flexible Automation”, Tata McGraw Hill Education Pvt. Ltd, 2010.
3. John J. Craig , “Introduction to Robotics”, Pearson, 2009.
4. Mikell P. Groover et. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.

REFERENCES:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated

Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
2. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
3. Spong & Vidyasagar, Robot Dynamics and Control, Mc Graw Hill.
4. Subir K Saha, Robotics, Mc Graw Hill.
5. M. P. Groover, Ashish Dutta, Industrial Robotics, McGraw Hill.

IEE052 **SENSORS AND TRANSDUCERS**

Pre-requisites of course: Basic Electrical Engineering, Basic signals & systems.

Course Outcomes Statement:

CO Statement	COs	*KL/BL*
Describe the working of commonly used sensors in industry for measurement of displacement, force and pressure.	**CO1**	**K2**
Recognize the working of commonly used sensors in industry for measurement of temperature, position, acceleration, flow and level.	**CO2**	**K1**
Identify the application of machine vision.	**CO3**	**K1**
Describe signal conditioning and data acquisition methods.	**CO4**	**K2**
Explain working of smart sensors and their applications in automation systems.	**CO5**	**K2**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE052.C1	3	2		2									1	1
IEE052.C2	3	2		2									1	1
IEE052.C3	3	2	1	1	3								1	1
IEE052.C4	3	3	2	2	3								1	1
IEE052.C5	3	2	1	1	2								1	1

Syllabus	Contact Hours
Unit-1:	**8**
Introduction to Transducer, Electrical Transducer and their advantages, Classification of transducers, Characteristics and choice of Transducers, Measurement of displacement using Potentiometer, LVDT & Optical Encoder, Measurement of force using load cells & strain gauges and its different types, Measurement of Pressure Using Electrical Transducers as Secondary Transducers & Piezoelectric Sensor.	
Unit-2:	**8**
Measurement of temperature using Thermistors, Thermocouples & RTD, Concept of Thermal Imaging; Measurement of position using Hall effect sensors; Proximity sensor: Inductive, Capacitive & Photoelectric, Seismic Transducers and their types, Flow Sensor: Ultrasonic & Laser; Level Sensor: Ultrasonic & Capacitive.	
Unit-3:	**8**
Machine Vision: Introduction to machine vision, Benefits of Machine Vision, Difference between machine vision and computer vision; Imaging Sensors: CCD and CMOS; Sensing & Digitizing function in Machine Vision, Image Processing and Analysis, Training the Vision System in a Pick and Place Robot.	
Unit-4:	**8**
Signal Conditioning: Introduction, Functions of signal conditioning equipment. Programmable Logic Controller: Introduction to PLC, Characteristic Function of PLC and Block Diagram. Data Acquisition Systems: Introduction, Component of Analog and Digital DAS, Objectives of DAS, Types of Multiplexing System, TDM and FDM.	
Unit-5:	**8**
Smart Sensors: General Structure of smart sensors & its components, Characteristic of smart sensors: Self calibration, Self-testing & self-communicating, Application of smart sensors: Smart city, Industrial robots & electric vehicles.	

Reference/Text Books

1. DVS Murthy, Transducers and Instrumentation, PHI 2nd Edition 2013.
2. D Patranabis, Sensors and Transducers, PHI 2nd Edition 2013.
3. S. Gupta, J.P. Gupta / PC interfacing for Data Acquisition & Process Control, 2nd ED / Instrument Society of America, 1994.

4. A.K.SAWHNEY, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai & Co. 19th Edition 2019.
5. Arun K. Ghosh, Introduction to measurements and Instrumentation, PHI, 4th Edition 2012.
6. A.D. Helfrick and W.D. cooper, Modern Electronic Instrumentation & Measurement Techniques, PHI – 2001.
7. Hermann K.P. Neubert, "Instrument Transducers" 2nd Edition 2012, Oxford University Press.

IEE053 **INDUSTRIAL AUTOMATION & CONTROL**

Pre-requisites of course: Digital Electronics

Course Outcomes:		**Knowledge Level, KL**
Upon the completion of the course, the student will be able to:		
CO1	Understand the concept of automation, its terminology and basic communication protocol.	**K2**
CO2	Apply Relay logic for automation.	**K3**
CO3	Learn about PLC, its operation and application in automation.	**K3**
CO4	Analyze the industrial sensors, its terminology and how one can interface with PLC.	**K3**
CO5	Demonstrate Pneumatic system and its application in industry.	**K3**

KL- Bloom's Knowledge Level (K1, K2, K3, K4, K5, K6)

K1 – Remember K2 – Understand K3 – Apply K4 – Analyze K5 – Evaluate K6 – Create

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE053.C1	3	2	1		2							1	1	1
IEE053.C2	3	2	1	2	1							1	1	1
IEE053.C3	3	3	1	2	2							1	1	1
IEE053.C4	3	3	1	2	2	1						1	1	1
IEE053.C5	3	3	1	2	2	1						1	1	1

Detailed Syllabus:

Unit1: Introduction of Automation system

Introduction: Introduction to Industrial Process Automation, Definition of Process-Meaning of Automation and Control, Necessity and Evolution of Automation-Role of Automation in Process Industry, Architecture of Industrial Automation ,Types of Automation Systems, Role of Information Technology in Process Automation-Process ,Challenges of Process Automation **-** Industry 1.0 to Industry 4.0.

Unit 2: Automation Using Relay Logic

Industrial automation relays switch circuits and act as memory devices. Contactors excel in high-current applications like DOL circuits, overcoming relay limitations. Automation faces relay issues such as wear and speed constraints. Sensors—optical, inductive, capacitive—and PNP/NPN types are crucial for precise PLC interfacing in industrial control.

Unit 3: Automation using PLC

Basics of PLC- I/O Devices of PLC-PLC Programming Devices-PLC Selection Criteria Design and Operation of PLC-Architecture of PLC-Central Control Unit of PLC-Functional Modes of PLC , PLC Program Structure and Execution, Ladder diagram, Sequential flow chart, ladder programming, Timer instructions – On delay, Off delay, Cyclic and Retentive timers, Up /Down Counters, math instructions.

Unit 4: Distributed Control System (DCS)

Computers in Process Automation, Architecture of Computer-Based Industrial Automation System, Hardware and Software Configuration-Process Automation Network-PC-Based Control Loop-Sampling of Process Data, Distributed Control System, Hardware Units of DCS-Communications in DCS Architecture, Monitoring, Control, and Data Acquisition in DCS-Integration of DCS with PLC and SCADA-DCS based Process Control Simulations.

Unit 5: Supervisory Control and Data Acquisition (SCADA)

Introduction-SCADA Basics-Different SCADA System Topologies-Evolution of SCADA, SCADA

Architecture-Functions of SCADA-Elements of SCADA-SCADA, DCS, and PLC: A Comparison-SCADA Security: Threats, Vulnerabilities, and Consequences-SCADA Standards Organizations-Application Areas of SCADA-SCADA and IOT SCADA Implementations for Automation Industries.

Textbooks:

1. Dey, Chanchal, and Sunit Kumar Sen, Industrial automation technologies, 2020, CRC Press.
2. Gilchrist, Alasdair, Industrial Internet use-cases. Industry 4.0., 2016, A press, Berkeley, CA.
3. Industrial Instrumentation and Control, by Singh, McGraw Hill.
4. Programmable Logic Controllers with Control Logix, by Jon Stenerson, Delmar Publishers, 2009.
5. Webb John W. and Reis A. Ronald, "Programmable Logic Controllers Principles and Applications" PHI, New Delhi, Latest edition.
6. Bolton W, "Programmable Logic Controllers" Elsevier India Pvt. Ltd. New Delhi.

Reference Books:

1. Johnson, David. Programmable Controllers for Factory Automation, 2020, CRC Press.
2. Sharma, K. L. S. Overview of industrial process automation, 2016, Elsevier.
3. Mikell P Groover, Automation, Production Systems and Computer Integrated.
4. Manufacturing, 2016, Pearson.
5. Frank D. Petruzella, Programmable Logic Controllers, 2019, Mc-Graw Hill.
6. B. Pneumatic Systems-Principles and Maintenance Mazumdar S.R.
7. John R Hackworth, "Programmable Logic Controllers" Pearson education New Delhi, Latest edition.

IEE054 ELECTRICAL STANDARDS AND ENGINEERING PRACTICES

Pre-requisites of course: Basic Electrical Engineering, Electrical Machines and Power System.

Course Outcomes:		**Knowledge Level, KL**
Upon the completion of the course, the student will be able to:		
CO1	Interpret different National & International Electrical Standards in practice.	**K2**
CO2	Describe Indian standards for cables, lighting and motors.	**K2**
CO3	Explain Indian standards of transformers, LV & HV switchgears.	**K2**
CO4	Describe the basic guidelines for National codes and design practices.	**K2**
CO5	Select the size and type of transformer, cable & switchgear for electrical applications.	**K4**

KL- Bloom's Knowledge Level (K1, K2, K3, K4, K5, K6)
K1 – Remember K2 – Understand K3 – Apply K4 – Analyze K5 – Evaluate K6 – Create

CO-PO Mapping Matrix/Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE054.C1	3	1	1	1									1	1
IEE054.C2	3	1	1	1									1	1
IEE054.C3	3	1	1	1									1	1
IEE054.C4	3	2	2	2									1	1
IEE054.C5	3	2	3	2									1	1

Detailed Syllabus:

Unit-I (Introduction of Standards and Design practices)

Different Electrical standards & codes, overview of Indian Standards and International Standards (IS, IEC, IEEE, NEMA and Building codes etc.).

General engineering design practices, selection of voltage level, role of electrical studies and design calculations (load flow, fault level calculation, earthing and lightning calculation) in distribution system planning. Electrical drawings/layouts and major cost components of engineering projects.

Unit-II (Electrical Standards-I)

Overview (Basic definitions, terminologies, type test and routine tests only) of IS standards for cables (IS-8130, IS-1255), IS standards for lighting (IS-3646, IS-6665) and IS standards for motors (IS-325). Efficiency class of motors as per IS/IEC standard.

Unit-III (Electrical Standards-II)

Transformer types, overview of IS standards (Basic definitions, terminologies, type test and routine tests only) for transformer (IS-2026, IS-6600), IS standards for LV & HV switchgears (IS-8623, IS/IEC-62271, IS-3427), type test and routine tests.

Instrument transformers (CT & PT), Instrument safety factor, VA burden, knee point voltage and accuracy classes.

Unit-IV (National Codes and Design practices)

Overview of National electrical code, Cable types, installation practices, de- rating factors and bonding methods, Thermal and electrical resistivity of soil, Earthing and lightning protection system, touch and step potentials, Hazardous area classification, electrical equipment for different hazardous zones.

Unit-V (Equipment Sizing & Selection, CEA Regulations)

Load estimation, sizing and selection of transformers, cables and switchgears, CEA Regulations 2010 and amendments, safety and installation guidelines.

Reference Books:

1. Robert Alonzo, "Electrical Codes, Standards, Recommended Practices and Regulations 1st Edition", Elsevier Inc.
2. Mohamed A El-Sharkawi, "Electric safety: practice and standards", CRC Press.
3. Central Electricity Authority Regulations and Amendments.

DEPARTMENT ELECTIVE-II

IEE055 OPTIMIZATION TECHNIQUES

Pre-requisites of course: Basic mathematics

Detailed Syllabus of Optimization Technique (IEE 055)

Course Outcomes Statement:

CO Statement	COs	*KL/BL*
Explain applications, classification of optimization techniques in engineering.	**CO1**	**K2**
Solve solving linear programming problems.	**CO2**	**K3**
Solve nonlinear programming problems.	**CO3**	**K3**
Explain Simulation, Project Management Techniques, Modern methods of Optimization.	**CO4**	**K2**
Apply optimization techniques to electrical engineering problems.	**CO5**	**K3**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE055.C1	3	3		2										
IEE055.C2	3	3		2										
IEE055.C3	3	3		3										
IEE055.C4	3	3		2	2									
IEE055.C5	3	3		3										

Syllabus	Contact Hours
Unit-1: Introduction to Optimization	**8**
Engineering application of Optimization, Statement of an optimization problem, Optimal problem formulation, Classification of optimization problem, Optimum design concepts: Definition of Global and Local optima using basic calculus concepts; Classical Optimization Techniques: Unconstrained Optimization - Single variable optimization, Constrained multivariable optimization with equality constraints - Lagrange multipliers method, Constrained multivariable optimization with inequality constraints - Kuhn-Tucker conditions.	
Unit-2: Linear Programming	**8**
Standard form of linear programming, Graphical solution, Simplex method, Big-M method, Duality theory, Decomposition principle, Transportation problem using North-West Corner rule and Least cost rule.	
Unit-3: Non-Linear Programming	**8**
Standard form of non-linear programming, One–Dimensional Minimization Methods - Unimodal function, Dichotomous search, interval halving method; Unconstrained Optimization Techniques - Univariate method, Steepest descent method; Constrained Optimization Techniques - Interior Penalty function method, Exterior penalty function method.	
Unit-4: Simulation, Project Management Techniques, Modern methods of Optimization:	**8**
Simulation: Definition, types of simulation, General process of simulation, advantages & disadvantages of simulation. **Project Management Techniques:** PERT and CPM **Modern methods of Optimization:** Genetic algorithm, working principle, fitness function, GA operators – crossover & mutation, comparison of GA with traditional methods.	
Unit-5: Case study (algorithm only)	**8**
Economic load scheduling of power plant (without considering losses), maintenance scheduling of machines in manufacturing industry, fuzzy-logic based speed control of DC machines.	

Text Books:

1. S. S. Rao, "Optimization - Theory and Applications", Wiley-Eastern Limited.
2. D.E. Goldberg, "Genetic Algorithm in Search Optimization and Machine Learning ", Addision-Wesley Publication, 1989.
3. Kwang Y. Lee, Mohamed A. El-Sharkawi, “Modern heuristic optimization techniques, Theory and applications to power systems”, Wiley-Interscience.

Reference Books:

1. David G. Luenberger,"Introduction of Linear and Non-Linear Programming ", Wesley Publishing Company.
2. Polak,"Computational methods in Optimization ", Academic Press.
3. Pierre D.A., "Optimization Theory with Applications", Wiley Publications.
4. Kalyanmoydeb,"Optimization for Engineering Design: Algorithms and Examples", PHI Publication.
5. L.P. Singh, "Advanced Power System Analysis and Dynamics ", Wiley Eastern Limited.
6. Olle I. Elewgerd " Electrical Energy System: An Introduction ", TMH Publication, New Delhi.

IEE056 Introduction to Machine Learning

Course Outcomes Statement:

CO Statement	COs	*KL/BL*
Explain the fundamental concepts and types of machine learning, including data pre-processing and evaluation metrics.	**CO1**	**K2**
Explain application of supervised learning algorithms to regression and classification tasks, addressing overfitting and underfitting, and optimizing models through hyperparameter tuning.	**CO2**	**K2**
Describe methods to analyze data using unsupervised learning techniques to identify patterns and reduce dimensionality.	**CO3**	**K2**
Describe architecture and training process of neural networks, and apply deep learning and ensemble techniques.	**CO4**	**K2**
Explain various applications of Machine Learning in Electrical Engineering.	**CO5**	**K2**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE056.C1	3	2			2								1	1
IEE056.C2	3	2	1	1	2								1	1
IEE056.C3	3	2	1		2								1	1
IEE056.C4	3	2	1		2								1	1
IEE056.C5	3	2	2		2								3	2

Syllabus	Contact Hours
Unit-1: Fundamentals of Machine Learning	**8**
Introduction to machine learning: Definition and applications, Types of machine learning: supervised, unsupervised, and reinforcement learning, Overview of key concepts: features, labels, training, testing, Workflow for applying machine learning on data, Pre-processing of data: normalization, standardization, handling missing values, Evaluation metrics: accuracy, precision, recall, f1 score.	
Unit-2: Supervised Learning Algorithms	**8**
Regression: linear and polynomial regression, Classification: logistic regression, k-nearest neighbors (KNN), decision trees, Support Vector Machines (SVM), Model training and evaluation techniques: Cross-Validation, bias-variance trade off, Overfitting and underfitting: concepts and mitigation strategies, Hyperparameter tuning: grid search, random search.	
Unit-3: Unsupervised Learning Algorithms	**8**
Clustering: k-Means, Hierarchical Clustering, DBSCAN, Dimensionality Reduction: Principal Component Analysis (PCA), t-Distributed Stochastic Neighbor Embedding (t-SNE), Anomaly Detection and its applications, Pre-processing for unsupervised learning.	
Unit-4: Advanced Topics in Machine Learning	**8**
Introduction to Neural Networks: perceptron, multilayer perceptron, Training Neural Networks: Backpropagation, Gradient Descent, Introduction to Deep Learning: Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Ensemble Methods: Bagging, Random Forests (RF), Boosting (AdaBoost, Gradient Boosting)	
Unit-5: Application of Machine learning in Electrical Engineering	**8**
Basic concepts of fuzzy logic, Load forecasting, Fault detection and diagnosis, Renewable energy integration, Demand response management, Smart grid optimization, Power Quality Monitoring, predictive maintenance. Case Study, Economic load scheduling of power plant (without considering losses), maintenance scheduling of machines in manufacturing industry.	

Text Books:

1. I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*, MIT Press, 2016.
2. T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning: Data Mining*,

Inference, and Prediction, Springer, 2009.
3. A. Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, O'Reilly Media, 2019.
4. Duda, R. O., Hart, P. E., and Stork, D. G., "Pattern Classification," 2nd ed. New York: Wiley-Interscience, 2001.

Reference Books:

1. Haykin, Simon. *Neural networks and learning machines, 3/E*. Pearson Education India, 2009.
2. K. P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press, 2012.
3. D. W. Patterson and A. S. Gibson, *Introduction to Artificial Intelligence and Machine Learning*, Pearson, 2019.
4. C. M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2006.

IEE057 **DIGITAL SIGNAL PROCESSING**

Pre-requisites of course: Basic Signals & System, Network Analysis & Synthesis.

Course Outcomes Statement:

CO Statement	COs	*KL/BL*
Describe the concept of discrete sequence and LTI systems, frequency domain of discrete sequence, Fourier transform. And represent the IIR & FIR Systems through structure.	**CO1**	**K2**
Describe of sampling of signal and its reconstruction, processing of continuous time and discrete time signals. Sampling rate variation and application of multi rate signal processing.	**CO2**	**K2**
Describe the concept of response of LTI system and linear phase systems & Computation of discrete Fourier transform (DFT) and calculate linear and circular convolution.	**CO3**	**K2**
Apply designing concepts of IIR & FIR filters with the desired specification by using various methods.	**CO4**	**K3**
Compute DFT using decimation in time and decimation in frequency both and also have the concept of other time –frequency representations and their application.	**CO5**	**K3**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE057.C1	3	2										1		
IEE057.C2	3	2	1	2	1							1		
IEE057.C3	3	3	1	2	2							1		
IEE057.C4	3	3	1	2	2							1		
IEE057.C5	3	3	1	2	2							1		

Syllabus	**Contact Hours**
Unit-1:	
Discrete-Time Signals and Systems: Sequences, discrete time systems, LTI systems, frequency domain representation of discrete time signals and systems, Fourier Transform. Implementation of discrete time systems: Structure for FIR system, Structure for IIR systems.	**8**
Unit-2:	
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.	**8**
Unit-3:	
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. **Discrete Fourier Transform:** Discrete Fourier Transform, properties, linear convolution and circular convolution.	**8**
Unit-4:	
Filter Design Techniques: Design of IIR filters using Impulse Invariant Response method and Bilinear Transformation method. Butterworth filters and Chebyshev Filter’s response, Design of FIR filters by windowing, Kaiser Window method.	**8**
Unit-5:	
Efficient computation of the DFT:	**8**

FFT algorithms- decimation in time and decimation in frequency, Goertzel algorithm, Implementation of the DFT using convolution. **Introduction to wavelet transform:** Wavelet comparison with Fourier transforms, Applications of Wavelet cosine transform, Discrete cosine transform (DCT).	

Text Books:

1. S. Salivahanan, “Digital Signal Processing”, McGraw Hill Education (India) Private Limited.
2. Oppenheim A.V., Schafer, Ronald W. & Buck, John R, ”Discrete Time Signal processing”, Pearson Education .

Reference Books:

1. Proakis, J.G. & Manolakis, D.G.,” Digital Signal Processing: Principles Algorithms and Applications”, Prentice Hall of India.
2. Rabiner, L.R. and Gold B., “Theory and applications of DSP”, Prentice Hall of India.
3. Oppenheim, Alan V. & Willsky, Alan S., “Signals and Systems”, Prentice Hall of India, 2nd Edition.
4. Johnson, J.R., “Introduction to Digital Signal Processing”, Prentice Hall of India.

IEE058 ANALOG & DIGITAL COMMUNICATION

Pre-requisites of course: Basic Signals & Systems.

Course Outcomes Statement:

CO Statement	COs	*KL/BL*
Describe the Amplitude Modulation in communication systems.	**CO1**	**K2**
Explain the Frequency & Phase modulation in communication systems.	**CO2**	**K2**
Explain the pulse modulation techniques in communication systems.	**CO3**	**K2**
Apply Digital Modulation Techniques and their use in communication systems.	**CO4**	**K3**
Apply the concept of Information Theory in Communication Engineering.	**CO5**	**K3**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE058.C1	2			2										
IEE058.C2	2	2	2	2										
IEE058.C3	2	2	1	3										
IEE058.C4	2	2	1	2										
IEE058.C5	2	2	1	3										

Syllabus	**Contact Hours**
Unit-1:	
Elements of communication system and its limitations, Amplitude modulation and detection, Generation and detection of DSB-SC, SSB and vestigial side band modulation, carrier acquisition AM transmitters and receivers, Super hetrodyne Receiver, IF amplifiers, AGC circuits, Frequency Division multiplexing.	**2**
Unit-2:	
Angle Modulation: Basic definition, Narrow-Band and wideband frequency modulation, transmission bandwidth of FM signals, Generation and detection of frequency modulation, Generation and detection of Phase Modulation. Noise: External noise, internal noise, noise calculations, signal to noise ratio.	**2**
Unit-3:	
Pulse Modulation: Introduction, sampling process, Analog Pulse Modulation Systems, Pulse Amplitude Modulation (PAM), Pulse width modulation (PWM) and Pulse Position Modulation (PPM). Waveform coding Techniques: Discretization in time and amplitude, Quantization process, quantization noise, Pulse code Modulation, Differential Pulse code Modulation, Delta Modulation and Adaptive Delta Modulation.	**2**
Unit-4:	
Digital Modulation Techniques: Types of digital modulation, waveforms for amplitude, frequency and phase shift keying, coherent and non-coherent methods for the generation of ASK, FSK and PSK. Comparisons of above digital modulation techniques.	**2**
Unit-5:	
Time Division Multiplexing: Fundamentals, Electronic Commutator, Bit/byte interleaving, TI carrier system, synchronization and signaling of TI, TDM and PCM hierarchy, synchronization techniques. Introduction to Information Theory: Measure of information, Entropy & Information rate, channel capacity, Hartley Shannan law, Huffman coding, shannan Fano coding.	**2**

Text Books:

1. Simon Haykin,“ Communication Systems” John Wiley & Sons 4th Edition.
2. G. Kennedy and B. Davis,” Electronic Communication Systems” 4th Edition, Tata McGraw Hill.
3. Simon Haykin, “Digital Communications” John Wiley & Sons.
4. T.L. Singal, “Analog & Digital Communication”, Tata Mc Graw Hill.

Reference Books:

1. B.P. Lathi, “Modern Analog & Digital Communication Systems” Oxford University Press.
2. Taub & Schilling, “Communication System: Analog and Digital” Tata Mc Graw Hill.
3. R.P. Singh & S.D. Sapre, “Communication Systems Analog and Digital” Tata McGraw Hil

DEPARTMENT ELECTIVE-III

IEE061 **SPECIAL ELECTRICAL MACHINES**

Pre-requisites of course: Electrical Machines-I & Electrical Machines-II.

Outcomes Statement:

CO Statement	COs	*KL/BL*
Describe the working principle, Constructional Features of different types of electrical machines including the fractional kilowatt machines.	**CO1**	**K2**
Illustrate torque-speed characteristics of different electrical machines and interpret their performance and identify the suitable machine for an operation.	**CO2**	**K3**
Explain different types of control techniques for a machine and identify the best control strategy based upon different constraints.	**CO3**	**K2**
Describe stepper, BLDCs, SRM, and other special machines in the area of the various industrial, domestic and commercial applications.	**CO4**	**K2**
Describe the working principle, constructional features of single-phase synchronous motor and commutator motors.	**CO5**	**K2**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE061.C1	3	2	2	2	2								1	1
IEE061.C2	3	2	2	2	2								1	1
IEE061.C3	3	2	2	2	2								1	1
IEE061.C4	3	2	2	2	2								1	1
IEE061.C5	3	2	2	2	2								1	1

Syllabus	**Contact Hours**
Unit-I:	**8**
Induction Machines: Concept of constant torque and constant power controls, SEIG, DFIG: Operating Principle, Equivalent Circuit, Characteristics, Applications, Linear Induction Motors. Construction, principle of operation, Linear force, and applications. **Two Phase AC Servomotors**: Construction, torque-speed characteristics, performance and applications.	
Unit-II:	**8**
Stepper Motors: Constructional features, Principle of operation, Variable reluctance motor, Hybrid motor, Single and multistack configurations, Torque equations, Characteristics, Drive circuits, Microprocessor control of stepper motors, Closed loop control, Applications.	
Unit-III:	**8**
Switched Reluctance Motors: Constructional features, Rotary and Linear SRM, Principle of operation, Torque production, performance characteristics, Methods of Rotor position sensing, Sensor less operation, Closed loop control and Applications.	
UNIT-IV	**8**
Permanent Magnet Machines: Permanent Magnet synchronous generator Operating Principle, Equivalent Circuit, Characteristics, Permanent magnet DC motors, sinusoidal PMAC motors, their important features and applications, PCB motors. **Permanent Magnet Brushless D.C. Motors**: Principle of operation, Types, Magnetic circuit analysis, EMF and torque equations, Commutation, Motor characteristics and control, Applications.	

UNIT-V:	8
Single phase synchronous motor; construction, operating principle and characteristics of reluctance and hysteresis motors; **Single Phase Commutator Motors:** Construction, principle of operation, characteristics of universal and repulsion motors;	

Reference/Text Books

1. K. Venkataratnam, ‘Special Electrical Machines’, Universities Press (India) Private Limited, 2008.
2. T.J.E Miller, ‘Brushless Permanent Magnet and Reluctance Motor Drives’, Clarendon Press, Oxford, 1989.
3. P.S. Bimbhra "Generalized Theory of Electrical Machines" Khanna Publishers.
4. T. Kenjo, ‘Stepping Motors and Their Microprocessor Controls’, Clarendon Press London, 1984.
5. M.G. Say "Alternating current Machines" Pitman & Sons.

IEE062 **ELECTRICAL MACHINE DESIGN**

Pre-requisites of course: Electrical Machine-I & Electrical Machine-II.

Course Outcomes Statement:

	CO Statement	COs	*KL/BL*
1	Describe insulating materials for electrical machines and calculate mmf and magnetizing current.	**CO1**	**K2**
2	Apply the concepts of design to obtain parameters of the core, yoke, windings and the cooling system of a transformer.	**CO2**	**K3**
3	Apply the concepts of design to obtain parameters of the core and armature design of DC and 3-phase synchronous machine.	**CO3**	**K3**
4	Apply the concepts of design to obtain parameters of three-phase induction motors, field system of DC machine and synchronous machines.	**CO4**	**K3**
5	Analyse computer aided design approaches and apply the concepts of optimization for the design of electrical machines	**CO5**	**K4**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE062.C1	2	2	2	2	2	-	-	-	-	-	-	1	1	1
IEE062.C2	2	2	2	2	2	-	-	-	-	-	-	1	1	1
IEE062.C3	2	2	2	2	2	-	-	-	-	-	-	1	1	1
IEE062.C4	2	2	2	2	2	-	-	-	-	-	-	1	1	1

Syllabus	**Contact Hours**
UNIT-I: Basic Considerations in Electrical Machine Design:	**9**
Basic concept of design, Major considerations in Electrical Machine Design- limitation in design, standardization, modern trends in design and manufacturing techniques, Electrical Engineering Materials – Space factor – Choice of Specific Electrical and Magnetic loadings - Thermal considerations -Heat flow – Temperature rise - Rating of machines – Standard specifications, Classification of insulating materials. Calculation of total mmf and magnetizing current.	
UNIT-II: Transformer Design:	**7**
Output equation, design of core, yoke and windings, overall dimensions, Computation of no load current to voltage regulation, efficiency and cooling system designs.	
UNIT-III: Design of rotating machines – I:	**8**
Output equations of rotating machines, specific electric and magnetic loadings, factors affecting size of rotating machines, separation of main dimensions, election of frame size, Core and armature design of dc and 3-phase ac machines.	
Unit-IV: Design of rotating machines– II:	**8**
Rotor design of three phase induction motors, Design of field system of DC machine and synchronous machines. Estimation of performance from design data.	
Unit-V: Computer Aided Design:	**8**
Philosophy of computer aided design, advantages and limitations. Computer aided design	

approaches analysis, synthesis and hybrid methods. Concept of optimization and its general procedure. Flow charts and 'c' based computer programs for the design of transformer, dc machine, three phase induction and synchronous machines.	

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:

3. M.G. Say, "The Performance and Design of AC Machines" Pitman & Sons.
4. A.E. Clayton and N.N. Hancock, "The Performance and Design of D.C. Machines" Pitman & Sons.
5. S.K. Sen, "Principle of Electrical Machine Design with Computer Programming" Oxford and IBM Publications.

IEE063 **DIGITAL CONTROL SYSTEM**

Pre-requisites of course: Control System

Course Outcomes Statement:

CO Statement	COs	*KL/BL*
Represent discrete time systems under the form of z-domain transfer functions and state-space models.	**CO1**	**K3**
Obtain the model of discrete-time systems by pulse transfer function.	**CO2**	**K3**
Analyze stability, transient response and steady state behaviour of linear discrete- time systems, analytically and numerically using tools such as MATLAB and Simulink	**CO3**	**K4**
Design sampled data control systems.	**CO4**	**K3**
Describe Discrete state space model and test controllability and observability of systems.	**CO5**	**K2**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE063.C1	3	2												
IEE063.C2	3	3												
IEE063.C3	3	3		2	3									
IEE063.C4	2		3	2										
IEE063.C5	3	3	3	3										

Syllabus	Contact Hours
Unit-1: Introduction to digital control	**8**
Introduction, Discrete time system representation, Mathematical modelling of sampling process, Data reconstruction.	
Unit-2: Modelling discrete-time systems by pulse transfer function	**8**
Revisiting Z-transform, Mapping of s-plane to z-plane, Pulse transfer function, Pulse transfer function of closed loop system, Sampled signal flow graph.	
Unit-3: Stability analysis of discrete time systems	**8**
Jury stability test, Stability analysis using bi-linear transformation. Time response of discrete systems: Transient and steady state responses, Time response parameters of a prototype second order system.	
Unit-4: Design of sampled data control systems	**8**
Root locus method, Controller design using root locus, Root locus-based controller design using MATLAB, Nyquist stability criteria, bode plot, Lead compensator design using Bode plot, Lag compensator design using Bode plot, Lag-lead compensator design in frequency domain.	
Unit-5: Discrete state space model	**8**
Introduction to state variable model, Various canonical forms, Characteristic equation, state transition matrix, Solution to discrete state equation. Controllability, observability and stability of discrete state space models: Controllability and observability, Stability, Lyapunov stability theorem.	

Reference/Text Books

1. B. C. Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007.
2. K. Ogata, Discrete Time Control Systems, Prentice Hall, 2/e, 1995.
3. M. Gopal, Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003.
4. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems, Addison Wesley, 1998, Pearson Education, Asia, 3/e, 2000.
5. K. J. Astroms and B. Wittenmark, Computer Controlled Systems - Theory and Design, Prentice Hall, 3/e, 1997.

IEE064 ELECTRIC AND HYBRID VEHICLES

Pre-requisites of course: Electrical Machines, Power Electronics

Outcomes Statement:

CO Statement	COs	*KL/BL*
Calculate vehicle dynamics mathematically and identify various vehicle drive train schemes.	**CO1**	**K3**
Explain the configuration and control of electrical propulsion unit of electric and hybrid vehicles.	**CO2**	**K2**
Explain various energy storage systems methods used for vehicle applications	**CO3**	**K2**
Identify the components of EV supply equipment and sizing of components of electric and hybrid vehicles.	**CO4**	**K2**
Explain energy management strategies of electric and hybrid vehicles.	**CO5**	**K2**

	CO-PO Mapping Matrix/Course Articulation Matrix													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
IEE064.C1	2	2	2										1	1
IEE064.C2	2	2	2										1	1
IEE064.C3	2	2	2										1	1
IEE064.C4	2	2	2										1	1
IEE064.C5	2	2	2			1	1						1	1

Syllabus	Contact Hours
Unit-1:	
Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles. **Conventional Vehicles**: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. **Hybrid Electric Drive-trains**: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. **Electric Drive-trains**: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.	**8**
Unit-2: Electric Propulsion unit	
Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	**8**
Unit-3: Energy Storage	
Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.	**8**
Unit-4: Sizing the drive system	
Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.	**8**
Unit-5: Energy Management Strategies	
Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.	**8**

Text Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

Reference Books:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

B.Tech. VI Semester

OPEN ELECTIVE-I

IOE061	REAL TIME SYSTEMS
IOE062	EMBEDDED SYSTEM
IOE063	INTRODUCTION TO MEMS
IOE064	OBJECT ORIENTED PROGRAMMING
IOE065	NUMERICALTECHNIQUES
IOE066	GIS & REMOTE SENSING
IOE067	UNDERSTANDING THE HUMAN BEING COMPREHENSIVELY-HUMAN ASPIRATIONS AND ITS FULFILLMENT

IOE061 REAL TIME SYSTEMS

Unit	Topics	Lectures
I	**Introduction** Definition, Typical Real Time Applications: Digital Control, High Level Controls, Signal Processing etc., Release Times, Dead-lines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Work load, Periodic Task Model, Precedence Constraints and Data Dependency.	8
II	**Real Time Scheduling** Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective-Deadline-First (EDF) and Least-Slack-Time-First (LST) Algorithms, Rate Monotonic Algorithm, OfflineVersusOnlineScheduling,SchedulingAperiodicandSporadicjobs In Priority Driven and Clock Driven Systems.	8
III	**Resources Sharing** Effect of Resource Contention and Resource Access Control (RAC), Non-preemptive Critical Sections, Basic Priority-Inheritance and Priority-Ceiling Protocols, Stack Based Priority- Ceiling Protocol, Use of Priority-Ceiling Protocol in Dynamic Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple-Module Resources, Controlling Concurrent Accesses to Data Objects.	8
IV	**Real Time Communication** Basic Concepts in Real time Communication, Soft and Hard RT Communication systems, Model of Real Time Communication, Priority-Based Service and Weighted Round-Robin Service Disciplines for Switched Networks, Medium Access Control Protocols for Broadcast Networks, Internet and Resource Reservation Protocols.	
V	**Real Time Operating Systems and Databases** Features of RTOS, Time Services, UNIX as RTOS, POSIX Issues, Characteristic of Temporal data, Temporal Consistency, Con-currency Control, Overview of Commercial Real Time databases.	8

Text Books:

1.Real Time Systems–Jane W.S. Liu, Pearson Education Publication.

Reference Books:

1. Real Time Systems– Mall Rajib, Pearson Education.
2. Real-Time Systems: Scheduling, Analysis, and Verification–Albert M.K. Cheng, Wiley.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Describe concepts of Real-Time systems and modeling.
2. Recognize the characteristics of areal-time system in context with real time scheduling.
3. Classify various resource sharing mechanisms and their related protocols.
4. Interpret the basics of real time communication by the knowledge of real time mode ls and protocols.
5. Apply the basics of RTO Sin interpretation of real time systems.

IOE062 EMBEDDED SYSTEM

COURSE OBJECTIVE: *After completion of the course student will be able to:*

1. Attain the knowledge of embedded system and its development environment.
2. Gain the knowledge of RTOS based embedded system design and its applications.

COURSE OUTCOME: *After completion of the course student will be able to:*

CO1: Understand the basics of embedded system and its structural units.
CO3: Analyze the embedded system specification and develop software programs.
CO3: Evaluate the requirements of the programming embedded systems, related software architecture.
CO3: Understand the RTOS based embedded system design.
CO3: Understand all the applications of the embedded system and designing issues.

IOE062 EMBEDDED SYSTEM		
Unit	**Topic**	**Lectures**
1	Introduction to Embedded Systems: Introduction to Embedded Systems – The build process for embedded systems- Structural units in Embedded processor, selection of processor & memory devices- DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.	**8**
2	Embedded Networking: Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols – RS232 standard – RS422 – RS485 – CAN Bus-Serial Peripheral Interface (SPI)–Inter Integrated Circuits(I2C)–need For device drivers.	**8**
3	Embedded Firmware Development Environment: Embedded Product Development Life Cycle objectives, different phases of EDLC, Modelling of EDLC; issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object oriented Model.	**8**
4	RTOS Based Embedded System Design: Introduction to basic concepts of RTOS-Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non preemptive scheduling, Task communication shared memory, message passing-, Inter process Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance, comparison of Real time Operating systems: VxWorks, чC/OS-II,RT Linux.	**8**
5	Embedded System Application Development: Design issues and techniques Case Study of Washing Machine- Automotive Application- Smart card System Application.	**8**

Text Books:

1. Wayne Wolf, “Computers as Components: Principles of Embedded Computer System Design”, Elsevier, 2006.
2. Michael J. Pont, “Embedded C”, Pearson Education,2007.
3. Steve Heath, “Embedded System Design”, Elsevier, 2005.
4. Muhammed Ali Mazidi, Janice Gillispie Mazidi and Rolin D. Mc Kinlay,“The 8051 Microcontroller and Embedded Systems”, Pearson Education, Second edition, 2007.

IOE063 INTRODUCTION TO MEMS

COURSE OBJECTIVE: *After completion of the course student will be able to:*

1. Understand the Basic concept of MEMS, Mechanics of Beam and Diaphragm Structures, Air Damping and Electrostatic Actuation.
2. Know the knowledge of Thermal Effects and the Applications of MEMS in RF.

COURSE OUTCOME: *After completion of the course student will be able to:*

CO1: Understand the Basic concept of MEMS Fabrication Technologies, Piezoresistance Effect, Piezoelectricity, Piezoresistive Sensor.
CO2: Explain Mechanics of Beam and Diaphragm Structures.
CO3: Understand the Basic concept of Air Damping and Basic Equations for Slide-film Air Damping, Couette-flow Model, Stokes-flow Model.
CO4: Know the concept of Electrostatic Actuation.
CO5: Understand the applications of MEMS in RF.

KOE063 INTRODUCTION TO MEMS		
Unit	**Topic**	**Lectures**
1	**Introduction to MEMS:** MEMS Fabrication Technologies, Materials and Substrates for MEMS, Processes for Micromachining, Characteristics, Sensors/Transducers, Piezoresistance Effect, Piezoelectricity, Piezoresistive Sensor.	**8**
2	**Mechanics of Beam and Diaphragm Structures:** Stress and Strain, Hooke's Law. Stress and Strain of Beam Structures: Stress, Strain In a Bent Beam, Bending Moment and the Moment of Inertia, Displacement of Beam Structures Under Weight, Bending of Cantilever Beam Under Weight.	**8**
3	**Air Damping:** Drag Effect of a Fluid: Viscosity of a Fluid, Viscous Flow of a Fluid, Drag Force Damping, The Effects of Air Damping on Micro-Dynamics. Squeeze-film Air Damping: Reynolds 'Equations for Squeeze-film Air Damping, Damping of Perforated Thick Plates. Slide-film Air Damping: Basic Equations for Slide-film Air Damping, Couette-flow Model, Stokes-flow Model.	**8**
4	**Electrostatic Actuation:** Electrostatic Forces, Normal Force, Tangential Force, Fringe Effects, Electrostatic Driving of Mechanical Actuators: Parallel-plate Actuator, Capacitive sensors. Step and Alternative Voltage Driving: Step Voltage Driving, Negative Spring Effect and Vibration Frequency.	**8**
5	**Thermal Effects:** Temperature coefficient of resistance, Thermo-electricity, Thermocouples, Thermal and temperature sensors. **Applications of MEMS in RF** MEMS Resonator Design Considerations, One-Port Micromechanical Resonator Modeling Vertical Displacement Two-Port Microresonator Modeling, Micromechanical Resonator Limitations.	**8**

Text & Reference Books:

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat and V. K. Atre, “Micro and smart systems”, Wiley India, 2010.
2. S.M. Sze, “Semiconductor Sensors”, John Wiley & Sons Inc., Wiley Inter science Pub.

3. M.J. Usher, “Sensors and Transducers”, McMillian Hampshire.
4. RS Muller, Howe, Senturia and Smith, “Microsensors”, IEEE Press.

IOE064 OBJECT ORIENTED PROGRAMMING

COURSE OBJECTIVE: After completion of the course student will be able to:

1. Understand the Basic concept of Object Orientation, object identity and Encapsulation.
2. Know the knowledge of Basic Structural Modeling, Object Oriented Analysis and C++ Basics.

COURSE OUTCOME: After completion of the course student will be able to:

CO1: Understand the Basic concept of Object Orientation, object identity and Encapsulation.
CO2: Understand the Basic concept of Basic Structural Modeling.
CO3: Know the knowledge of Object oriented design, Object design.
CO4: Know the knowledge of C++ Basics.
CO5: Understand the Basics of object and class in C++.

KOE-064 OBJECT ORIENTED PROGRAMMING		
Unit	**Topic**	**Lectures**
1	Introduction: The meaning of Object Orientation, object identity, Encapsulation, information hiding, polymorphism, generosity, importance of modelling, principles of modelling, object Oriented modelling, Introduction to UML, conceptual model of the UML, Architecture.	**8**
2	Basic Structural Modeling: Classes, Relationships, common Mechanisms, and diagrams. Class &Object Diagrams: Terms, concepts, modelling techniques for Class & Object Diagrams. Collaboration Diagrams: Terms, Concepts, depicting a message, polymorphism in collaboration Diagrams, iterated messages, use of self in messages. Sequence Diagrams: Terms, concepts, depicting asynchronous messages with/without priority, call-back mechanism, broadcast messages. Basic Behavioural Modeling: Use cases, Use case Diagrams, Activity Diagrams, State Machine , Process and thread, Event and signals, Time diagram, interaction diagram, Package diagram. Architectural Modeling: Component, Deployment, Component diagrams and Deployment diagrams.	**8**
3	Object Oriented Analysis: Object oriented design, Object design, Combining three models, Designing algorithms, design optimization, Implementation of control, Adjustment of inheritance, Object representation, Physical packaging, Documenting design considerations. Structured analysis and structured design (SA/SD), Jackson Structured Development (JSD).Mapping object oriented concepts using non-object oriented language, Translating classes into data structures, Passing arguments to methods, Implementing inheritance, associations encapsulation. Object oriented programming style: reusability, extensibility, robustness, programming in the large. Procedural v/s OOP, Object oriented language features. Abstraction and Encapsulation.	**8**
4	C++ Basics : Overview, Program structure, namespace, identifiers, variables, constants, enum, operators, typecasting, control structures C++ Functions : Simple functions, Call and Return by reference, In line functions, Macro Vs. In line functions, Over loading of functions, Default arguments, friend functions, virtual functions.	**8**
5	Objects and Classes : Basics of object and class in C++, Private and public members, static data and function members, constructors and their types, destructors, operator overloading, type conversion. Inheritance: Concept of Inheritance, types of inheritance: single, multiple, multilevel, hierarchical, hybrid, protected members, overriding, virtual base class Polymorphism: Pointers in C++, Pointes and Objects, this pointer, virtual and pure virtual functions, Implementing polymorphism.	**8**

Text Books:

1. James Rumbaughet. al, “Object Oriented Modeling and Design”, PHI.
2. Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified Modeling Language User Guide”, Pearson Education
3. Object Oriented Programming with C++,E Balagurusamy, TMH

Reference Books:

1. R.S. Salaria, Mastering Object Oriented Programming with C++, Khanna Publishing House.
2. C++ Programming, Black Book, Steven Holzner, dream tech
3. Object Oriented Programming in Turbo C++, Robert Lafore, Galgotia.
4. Object Oriented Programming with ANSI and Turbo C++, Ashok Kamthane, Pearson.
5. The Compete Reference C++, Herbert Schlitz, TMH.
6. C++ and Object Oriented Programming Paradigm, PHI.
7. C++:How to Program, 9th Edition, Deitel and Deitel, PHI.

IOE065 NUMERICAL TECHNIQUES

COURSE OBJECTIVE: Students undergoing this course are expected to-

1. Understand about the basics of numerical techniques and its applications to Engineering Problems.

COURSE OUTCOME: After completion of the course student will be able to-

CO1: Understand about the basics of Ordinary Differential Equations, Separable equations, Equations made separable by change of variables.
CO2: Retrieve the information content of Power series method.
CO3: Apply problem specific Bessel's equation, Bessel Functions to engineering applications.
CO4: Understand about the basics of matrix, Eigen values and eigen vectors.
CO5: Analysis of Stage wise Processes by the Calculus of Finite Differences, Countercurrent Liquid- Liquid Extraction.

KOE065 NUMERICAL TECHNIQUES		
Unit	**Topic**	**Lectures**
1	Ordinary Differential Equations, Separable equations, Equations made separable by change of variables, Homogeneous Equations, Equations with first order and first degree with linear coefficients, Exact equations, Linear equation of first order, Bernoulli's equation, Other integrating factors, Integration of Exact equations, Equations of first order and higher degree, Clairaut's equation, Singular solutions, Equations with missing terms, General properties of Linear equations, Linear equations with constant coefficients, Determination of the complementary function, exponential functions, Determination of the particular integral, The Euler equation, Simultaneous Linear Differential equations.	**8**
2	Power series method, theory of the power series method, Legendre's equation, Legendre's Polynomials, Frobenius Method.	**8**
3	Bessel's equation, Bessel Functions Jv(x), Bessel Functions Jv(x) for any v≥0.Gamma Function, Solution J-v(x) of the Bessel Equation, Backbones of Bessel's Theory, Jv(x) with v= ±1/2, ±3/2, ±5/2.	**8**
4	Definition of matrix, Some special definitions and operations involving matrices, Determinants, Theorems on determinants, Inverse of a matrix, Orthogonal and unitary matrix. Orthogonal vectors, System of linear equations, Systems on n equations with n unknowns, Cramer's Rule, Eigen values and eigen vectors.	**8**
5	Analysis of Stage wise Processes by the Calculus of Finite Differences, Countercurrent Liquid- Liquid Extraction, Solution of Difference Equations, Stirred-Tank Reactor System, Distillation in a Plate Column, Unsteady-state Operation, Starting a Stirred-tank Reactor, Rate at which a Plate Absorber Approaches Steady State.	**8**

Text & Reference books:

1. Mickley, Reid and Sherwood, "Applied Mathematics in Chemical Engineering", Tata McGraw Hill, New Delhi (1981).
2. E. Kreyszig, "Advanced Engineering Mathematics", 8th edition, John Wiley and Sons(1999).
3. M.R. Spiegel, "Advanced Mathematics for Engineers and Scientists", Schaum Outline Series, McGraw Hill, (1971).
4. Chandrika Prasad, Reena Garg, "Advanced Engineering Mathematics", Khanna Publishing house.

IOE066 GIS & REMOTE SENSING

COURSE OBJECTIVE: *Students undergoing this course are expected to-*

1. Understand about the principles of GIS, Remote Sensing, Spatial Systems, and its applications to Engineering Problems.

COURSE OUTCOME: *After completion of the course student will be able to-*

CO1: Understand about the principles of Remote Sensing and its advantages and limitations.
CO2: Retrieve the information content of remotely sensed data.
CO3: Apply problem specific remote sensing data for engineering applications.
CO4: Analyze spatial and attribute data for solving spatial problems.
CO5: Create GIS and cartographic outputs for presentation.

IOE066 GIS & REMOTE SENSING		
Unit	**Topic**	**Lectures**
1	Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows; principal applications of different wave length regions; typical Spectral reflectance curve for vegetation, soil and water, spectral signatures.	**8**
2	Different types of sensors and platforms; contrast ratio and possible causes of low contrast; aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography-end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; air-photointerpretation-interpretation elements.	**8**
3	Photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography; satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, Vegetation indices.	**8**
4	Microwave remote sensing. GI Sand basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties. .	**8**
5	Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS, Application of remote sensing and GIS for the management of land and water resources.	**8**

Text & Reference Books:

1. Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
2. Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
3. George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
4. Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
5. Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.

6. Sabins, F.F.2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.

IOE067 UNDERSTANDING THE HUMAN BEING COMPREHENSIVELY– HUMAN ASPIRATIONS AND ITS FULFILLMENT

Course Objectives:

1. To help the students having the clarity about human aspirations, goal, activities and purpose of life.
2. To facilitate the competence to understand the harmony in nature/existence and participation of human being in the nature/existence.
3. To help the students to develop the understanding of human tradition and its various components.

Course Methodology:

1. The methodology of this course is exploration and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
2. It is free from any dogma or set of do's and don'ts related to values.
3. It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated and encouraged to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation.
4. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self-evolution.
5. This self-exploration also enables them to critically evaluate their preconditioning and present beliefs.

KOE-067 UNDERSTANDING THE HUMAN BEING COMPREHENSIVELY- HUMAN ASPIRATIONS AND ITS FULFILLMENT		
Unit	**Topic**	**Lectures**
1	**Introduction:** The basic human aspirations and their fulfillment through Right understanding and Resolution; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution.	**8**
2	**Understanding Human being and its expansion:** The domain of right understanding starts from understanding the human being (the knower, the experience and the doer); and extends up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in Existence (human conduct).	**8**
3	**Activities of the Self:** Understanding the human being comprehensively is the first step and the core theme of this course; human being as co-existence of these lf and the body; the activities and potentialities of the self; Reasons for harmony/contradiction in the self.	**8**
4	**Understanding Co-existence with other orders:** The need and the process of inner evolution (through self-exploration, self awareness and self-evaluation)- particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/order leading to Comprehensive knowledge about the existence).	**8**
5	**Expansion of harmony from self to entire existence:** Understanding different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavour viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from self to Nature And entire Existence.	**8**

Reference Books:

1. A Foundation Course in Human Values and Profession Ethics (Text Book and Teachers' Manual), R. R. Gaur, R. Sangal, G. P. Bagaria (2010), Excel Books, New Delhi [ISBN 978-8-174-46781-2]
2. Avartansheel Arthshastra, A. Nagraj, Divya Path Sansthan, Amarkantak, India.
3. Economy of Permanence – (a quest for social order based on non-violence), J. C. Kumar appa (2010), Sarva-Seva-Sangh-Prakashan, Varansi, India.
4. Energy and Equity, IvanIllich (1974), The Trinity Press, Worcester & Harper Collins, USA.
5. Ishandi Nau Upnishad, Shankaracharya, Geeta press, Gorakhpur,
6. Manav Vyavahar Darshan, A.Nagraj, Divya Path Sansthan, Amarkantak, India
7. Manaviya Sanvidhan, A. Nagraj, Divya Path Sansthan, Amarkantak, India.