ELECTRICAL ENGINEERING

Course Name	**:**	**INTRODUCTION TO ELECTRICAL ENGINEERING**
Course Code	**:**	**EEN 101**
Credits	**:**	**2**
L T P	**:**	**2 0 0**

Course Objectives:
At the end of this course, the student should be able to acquire basic knowledge of fundamentals of Electrical Engineering along with energy resources, generation, transmission, distribution and utilization of electrical energy.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**OVERVIEW OF ELECTRICAL ENGINEERING** General introduction to the field of Electrical Engineering and its sub- disciplines.	**1**
2	**ENERGY RESOURCES** Conventional and non-conventional energy resources; Availability of resources; Principle of energy conversion and its utilization; National and International energy trends; Global warming and greenhouse effects.	**3**
3	**GENERATION** Generation of electrical power, synchronous generator; Conventional power generation – Hydro, Thermal, Nuclear and Gas Power; Renewable energy generation; Generated voltage waveform, voltage and frequency level; Governor and Excitation System.	**4**
4	**TRANSMISSION** Purpose of transmitting power, AC transmission voltage levels; Power transformer; Transmission lines, single line diagram of power transmission network; Protective Equipments used in the network; Types of faults; Transmission substation; HVDC Transmission.	**4**
5	**DISTRIBUTION** Distribution network and substation; single line diagram of distribution network; Distribution transformer; Overhead lines and underground cables; Protective equipment, grounding and earthing.	**4**
6	**ELECTRICAL MACHINES** Transformers – principle, construction and operation; Rotating Machines-types.	**2**
7	**UTILIZATION** Types of load- Heating, motor, traction, lighting and fans; Load characteristics; Consumer loads; Power electronic equipment.	**3**
8	**METERING** Active and reactive power, apparent power, voltage, current and power measurement; Energy meters.	**3**
9	**ELECTRICAL WIRING CONCEPTS** Residential wiring diagram, Symbols of Switches, Fuse, rheostat, SPDT, DPDT, contacts, contactors, MCB. Safety and Protection	**2**
10	**POWER QUALITY AND CONTROL** Nature of non linear loads; Problems due to non-sinusoidal current; Use of electronics, microprocessor and control systems.	**2**

Course Outcomes: By the end of this course, the student will be able to:	
1	Understand the fundamentals of Electrical Engineering and become familiar with the field of Electrical Engineering and its various sub-disciplines.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**

1	Basic Electrical Engineering by D. P. Kothari, I.J Nagrath, McGraw Hill	2009
2	Beaty H.W., Fink D.G., "Standard Handbook for Electrical Engineers", McGraw Hill 15th Edition	2007
3	Singh, S.N., "Electric Power Generation, Transmission and Distribution", Prentice Hall of India, 2nd Edition,	2010
4	Mullin Ray C., "Electrical Wiring Residential", Delmar Publishers Inc., 11th edition,	1993
5	Electrical Engineering Fundamentals by Vincent Del Toro, PHI, 2nd Edition,	2003
6	Das Kamalesh, "Electrical Power Systems for Industrial Plants", JAICO Publishing House,	2011
7	Jelley N., Andrews John, " Energy Sciences – Principles, Technologies, and Impacts", Oxford University Press,	2011

Course Name	**:**	**NETWORKS AND SYSTEMS**
Course Code	**:**	**EEN 102**
Credits	**:**	**04**
L T P	**:**	**3- 0- 2**

Course Objectives:
At the end of this course, the student should be able to acquire knowledge of the fundamentals of network analysis using matrices, two-port and multi-port networks, and network synthesis and filter circuits.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**SINUSOIDAL STEADY STATE ANALYSIS** Sinusoids, Phasors, Impedance and admittance, Kirchhoff's law in frequency domain, impedance combinations, Steady State Analysis: Nodal and Mesh analysis, thevenin and Norton equivalent. AC Power Analysis: Instantaneous and average power, max average power transfer, RMS value, apparent power and power factor, complex power, conservation of AC power. Three Phase Circuits: types of load and source connections, power in balanced three phase circuits, star delta transformations. Network Theorems: compensation, superposition, reciprocity, millman and tellegen theorem.	8
2	**TRANSIENT NETWORK ANALYSIS** Continuous time and discrete time signals, systems and their properties: causality, stability, time invariance, linearity, invertibility, stability. Complex frequency and Laplace transforms, circuits analysis in s domain, poles, zeros, transfer Functions and driving point impedances and convolution. Step and impulse response of RL, RC, LC, RLC circuits, initial and final conditions. Fourier analysis of circuits with non-sinusoidal periodic excitation.	12
3	**NETWORK TOPOLOGY** Concept of Network Graphs, tree, link, cut set, network matrices, node incidence matrix, loop incidence matrix, cut set incidence matrix, network analysis using network incidence matrices.	4
4	**TWO PORT NETWORKS AND THEIR CHARACTERIZATION** Open circuit, short circuit, hybrid and transmission parameters, series parallel and tandem connection of two port networks, multi port networks, multi terminal networks, indefinite admittance matrix and its properties.	8
5	**NETWORK SYNTHESIS** Elements of realizability theory: causality and stability, hurwitz polynomials, positive real functions, elementary synthesis procedure. Synthesis of one port network with two kind of element: L-C Driving point Immitances, synthesis of R-L-C Functions. Synthesis of Transfer Functions : Properties of transfer functions, Zeros of transmission, synthesis of Y_{21} and Z_{21} with a 1-Ω termination, synthesis of constant resistance networks.	6
6	**INTRODUCTION TO FILTERS**	4

	Series and parallel resonance, single and double tuned circuits. Passive filters: lowpass, highpass, bandpass and bandstop filters. Difference between actual and ideal frequency response.	

List of Experiments:		**Number of Turns**
1	To verify Kirchoff's current law and Kirchoff's voltage law	1
2	To verify superposition theorem.	1
3	To verify Thevenin's theorems	1
4	To verify Norton's theorems	1
5	To verify Maximum power transfer theorems.	1
6	To determine transient response of current in RL and RC circuits with step voltage input and to do its simulation.	1
7	Determination of transient response of current in RLC circuit with step voltage input for under damped, critically damped and over damped cases and to do its simulation.	2
8	To study resonance in series RLC circuit and to do its simulation.	1
9	To study parallel RLC circuits and plot various responses and to do its simulation.	1
10	To verify the line voltage and phase voltage, and line current and phase current relationship in a star and delta three phase balanced circuit and to do its simulation.	1
11	To find various two port network parameters (open circuit, short circuit, transmission and hybrid).	1
12	To determine the node voltages and branch currents in a resistive network.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Acquire knowledge of the fundamentals of network analysis using matrices, two-port and multi-port networks, network synthesis and filter circuits.
2	Analyze DC and AC (single and three phase) circuits making use of various circuit techniques.
3	Analyze the magnetic circuits.
4	Analyze various types of two port networks and their inter connection.
5	Design and conduct experiments, as well as analyze and interpret data.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Network Analysis by M E Van Valkenburg, PHI, 3rd edition	1980
2	Fundamentals of Electric Circuits by C K Alexander & Matthew N O Sadiku, Mc Graw Hill, 2nd edition.	2003
3	Engineering Circuit Analysis by W H Hayt, J E Kemmerly & S M Durbin Tata McGraw Hill Education, 6th edition.	2005
4	Network Analysis & Synthesis by FF Kuo, Wiley India Private Limited; 2nd edition.	2006

Course Name	**:**	**ELECTRICAL MEASUREMENT AND INSTRUMENTATION**
Course Code	**:**	**EEN 103**
Credits	**:**	**04**
L T P	**:**	**3- 0- 2**

Course Objectives:
To be able to knowledge of principles of measurement of electrical quantities, construction and operating principles of electrical instruments, their static and dynamic characteristics, and errors in measurement and apply knowledge of measuring instruments to other areas of electrical engineering.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Functional elements of an instrument, static and dynamic characteristics, errors in measurement, statistical evaluation of measurement data, standard and calibration. Measurement of Error, Accuracy and Precision, significant figures, types of error, Statistical analysis of data, probability of errors, limiting errors.	6
2	**ANALOG INSTRUMENTS** Electromechanical instruments – moving, coil, moving iron, electrostatic instruments, current, voltage and power measurements, induction type energy meter, frequency meter, power factor meter, megger, magnetic measurements, instrument transformers.	10
3	**SENSORS AS TRANSDUCERS** Classification of Transducers, selection of transducers: resistive, capacitive and inductive transducers, piezo electric Transducers, optical and digital transducers, transducers for measurement of displacement, temperature, level, flows, pressure, velocity and acceleration.	8
4	**BRIDGE MEASUREMENTS** Wheatstone Bridge, Kelvin Bridge, ac. bridge and their application for the measurement of self-inductance and mutual inductance, Wagner Ground connection, measurement of capacitance, Measurement of low and high resistance.	7
5	**ANALOG ELECTRONIC INSTRUMENTATION** Analog electronic voltmeters, tuned and sampling voltmeters, Analog electronic wattmeter and energy meter.	3
6	**SIGNAL GENERATORS AND ANALYZERS** Introduction to signal generators, characteristics of signal generators, multi-vibrators, CRO, harmonic distortion and spectrum analyzer.	3
7	**DIGITAL ELECTRONIC MEASUREMENT** Digital counter-timer and frequency meter, time standards, digital voltmeter and multimeter, accuracy and resolution considerations, comparison with analog electronic instruments.	5

List of Experiments:		**Number of Turns**
1	To calibrate dc. voltmeter by direct reading dc. potentiometer.	1
2	To measure active and reactive power in a single phase circuit by one Wattmeter method.	1
3	To measure active and reactive power in a three-phase circuit by two Wattmeter method.	1
4	To measure power and power factor by two wattmeter method incorporating instrument transformers.	1
5	To calibrate a single phase energy meter with the help of a Wattmeter.	1
6	To measure voltage, current and impedance by oscilloscope.	1
7	To measure frequency and phase difference of a sinusoidal ac voltage using CRO.	1
8	To study a strain gauge and plot its response to an application using Wheatstone bridge.	1
9	To plot the characteristics of a thermistor and calibrate it for temperature measurement.	1
10	To measure insulation resistance using megger.	1
11	To measure sensitivity of Wheatstone bridge in half bridge and full bridge mode using strainguage.	1
12	To plot I/O characteristics of various inductive, capacitive and optical transducers.	2

Course Outcomes: By the end of this course, the student will be able to:	
1	Knowledge of principles of measurement of electrical quantities, construction and operating principles of electrical instruments, their static and dynamic characteristics, and errors in measurement.
2	Design and conduct experiments, as well as to analyze and interpret data.
3	Apply knowledge of measuring instruments to other areas of electrical engineering.

Suggested Books:		
Sr.	**Name of Book/ Authors/ Publisher**	**Year of**

No.		Publication/ Reprint
1	Doebeling, E.O., Measurement Systems – Application and Design, McGraw Hill Publishing Compnay.	1990
2	Mooris. A.S., Principle of Measurement and Instrumentation, Prentice Hall of India	1999
3	Dalley, J.W., Riley, W.F. and Meconnel, K.G., Instrumentation for Engineering Measurement, John Wiley & Sons	1999
4	A.K.Sawhney, A course in Electrical and Electronics Measurements and Instruments, DhanpatRai& Co. (Pvt.) Ltd.	2000

Course Name	**:**	**MECHATRONICS**
Course Code	**:**	**EEN 201**
Credits	**:**	**04**
L T P	**:**	**3-0-2**

Course Objectives:

At the end of this course the student should be able to have basic knowledge of mechatronics and its interdisciplinary applications i.e. integration of Mechanical engineering with Electrical & Electronics Engineering and Computer Technology. He should be able to design and conduct experiments as well as to analyze and interpret data.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**INTRODUCTION TO MECHATRONICS** Introduction to Mechatronics System, Trends in Mechatronics (Evolution), Definitions of Mechatronics, Key Elements of Mechatronics.	3
2	**SYSTEMS AND INTELLIGENCE** System, Classification of System, Mechanistic System Classification: Based on Input Energy, Mathematical Model and Function, Machine, Parts of Machine, Concepts of Machine, Classification of Machines based on Function and Size, introduction to induction motor, stepper motor, servomotor, linear motor. System Intelligence , Properties of Intelligent System, System Intelligence Levels, Human Intelligence System, Future Generation System Intelligence Level, Expressing System Intelligence	8
3	**SENSOR AND TRANSDUCER** Introduction, Energy and Signal Flow in a Measurement System, Role of Measurement System**,** Sensors in Mechatronics System, Difference between Sensors and Transducers, Classification of Sensors, Based on Sensor Output Signal, Sensor Input Physical Parameters, Sensor Accuracy (Smart/Intelligent Sensor), Performance Terminology, Static Characteristics, Dynamic Characteristics. Vision systems.	7
4	**SIGNAL CONDITIONING DEVICES** Signal Conditioning Processes, Signal Filtering, Circuit Protection, Signal Conversion, ADC and DAC, Logic Gates, Design of transducer, ADC-DAC interface using AIA.	4
5	**ACTUATORS** Actuators, Types of Actuators, Mechanical Actuation System, Electrical Actuation System, Pneumatic and Hydraulic Actuation System.	4
6	**INTELLIGENT CONTROL** Interfacing controller to System, On- Off Control, Continuous and discrete process Controller, Digital Logic Controller, Sequence Controller, Supervisory Controller , Direct Digital Controller Microprocessor, Microcontroller. PLC Controller: Different types of PLCs, Micro PLC, Modular PLC, I/O addressing, Memory organization of PLC, Programming of PLC, and application example. SCADA, HMI, Advanced Control Applications in Mechatronics.	12

7	**FAULT DIAGNOSTICS** System Fault Finding Techniques, Types of Fault Detection Technique, Fault Detection in Sensors, Fault Detection in Signal conditioning Devices, Fault Detection in Controlling Devices, Fault Detection in Actuators	4
8.	**CASE STUDY** CNC, Bio mimicry, pick and place robot, sorting and packaging.	

List of Experiments:		**Number of Turns**
1	To study various components of stepper motor and servo motor.	1
2	To study various components of Induction Machine and Synchronous Machine	1
3	To study various components of DC Machines and Transformers.	1
4	To verify truth-tables of various flip-flops (J-K, D, Toggle etc.)	2
5	To study the characteristics of LVDT using linear displacement trainer Kit & compare with ideal characteristics.	1
6	To measure the strain of the metal strip using strain gauge trainer kit & compare with ideal characteristics.	1
7	To measure the angular displacement of resistive & capacitive transducer using angular displacement trainer kit & compare with ideal characteristics.	1
8	To obtain the characteristics of RTD, Thermistor, thermocouple with hot and cold junction thermal trainer kit & compare with ideal characteristics.	1
9	To study different types of Actuators.	2
10	To experimentally study PLC interfacing of I/O and I/O addressing.	1
11	To perform any basic sequence programming using PLC.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Students were able to have basic knowledge of mechatronics and its interdisciplinary applications i.e. integration of Mechanical engineering with Electronics
2	Students were able to design and conduct experiments

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Mechatronics, fourth edition, by W Bolton. ISBN 978-81-317-3253-3	2013
2	Dan Necsulescu Mechatronics published by Pearson Education (Singapore) Pvt. Ltd., Indian Branch, 482 FIE, Patparganj, Delhi India.	2001
3	Book by H M T Limited, Mechatronics Tata McGraw Hill Publishing Company Limited, New Delhi.	1988
4	Mechatronics Principles, Concepts & Applications by Nitaigour P Mahalik published by TMH	2003

Course Name	**:**	**ELECTRICAL POWER SYSTEMS**
Course Code	**:**	**EEN202**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
At the end of this course the student should be able to have knowledge of electric power generation system, transmission and distribution system.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**GENERATION SYSTEMS** Principles of hydro, thermal, nuclear and renewable generation. connected load, maximum demand, demand factor, diversity factor, types of load, chronological load curve, load duration curve, mass curve, load factor, capacity factor, plant utilization factor; base, peak and standby stations, selection of number and size of units.	10
2	**TRANSMISSION SYSTEMS** Overhead and underground transmission, transmission voltages. Introduction to HVDC transmission. Conductor materials, solid stranded, ACSR, hollow and bundle conductors. Different types and supporting structures and towers for over-head lines. Parameters of transmission lines: calculation of resistance, inductance and capacitance for different configuration of overhead transmission lines. Elementary idea about transmission lines construction and Erection. Corona and its effect.	9
3	**DISTRIBUTION SYSTEM** Radial, ring main network distribution systems. Distribution Voltage, Choice of conductor size for distributors. Type and location of distribution substations. Main equipment in distribution sub-station, supporting structures for distribution line conductors. Distribution system voltage regulation.	6
4	**INSULATORS** Insulating materials, Types of insulators, voltage distribution over an insulator string. String-efficiency, Equalizing voltage drops across insulators of a string.	4
5	**CABLES** Insulating materials, Types of LV and HV cables, Three core solid, oil filled and Gas pressure cables, Effective conductor resistance, inductive reactance and capacitance of cables, grading of cables, Sheath and dielectric loss in cables, Elementary ideas about cable breakdown.	4
6	**PERFORMANCE AND MODELING OF TRANSMISSION LINES** Short transmission lines, voltage drop, regulation and efficiency calculations, Medium transmission lines. Normal T and PI, solution for voltage drop, regulation and efficiency. Long Transmission lines, current and voltage relations, ABCD constants, circle diagrams, charging current and Ferranti effect.	9

List of Experiments:		**Number of Turns**
1	To design distribution network and measurement of voltage and current distribution in distributors	1
2	To measure Potential distribution across different units of a string of insulators with and without guard ring.	1
3	To study of different parts of a power cable and measurement of insulation resistance of a cable.	1
4	To plot equi-potential curve and voltage gradient in a) Two/three -core cable b) Single-core cable.	2
5	To obtain Voltage Regulation of a long transmission line with resistive inductive and capacitive loads.	1
6	To obtain Voltage Profile of a long transmission line when: a. Open circuited b. Using shunt/series capacitive compensation c. Using shunt inductive compensation.	1
7	To design transmission & distribution network of a city using software.	1
8	To measure core to core & core to sheath capacitance of a three phase cable.	1
9	To simulate a small Hydro Plant using simulation software	2

10	To plot Voltage/Current characteristics of a solar cell and determination of its parameters.	1
11	To study different types of Line insulators and obtain breakdown characteristics of any one type of insulator	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Acquire basic knowledge of electric power generation, transmission and distribution systems.
2	Model and represent the transmission lines in power system.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Electrical Power Systems by C.L. Wadhwa, New Age International Ltd	2010
2	Modern Power System analysis by I.J.Nagrath&D.P.Kothari, Tata McGraw Hill	2003
3	Power System Analysis & Design by B R Gupta, S Chand & Co	2001
4	Electrical Power Generation, Transmission and distribution by S N Singh, PHI Publication	2008
5	Power System Analysis by John Grainger &W D Stevenson, McGraw Hill	1994

Course Name	**:**	**ELECTRICAL MACHINES - I**
Course Code	**:**	**EEN 203**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:
At the end of this course the student should be able to have knowledge of constructional features, principle of operation of various types of transformers and DC machines, analyze magnetic circuits and evaluate the performance of transformers and DC machines.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**MAGNETIC CIRCUITS** Magnetic Circuit properties, Magnetic materials, magnetic circuit calculation, transformer magnetic circuit, machine magnetic circuit.	**3**
2	**SINGLE PHASE STATIC TRANSFORMERS** Introduction to transformers types, core, winding, insulation, induced voltage, transformer on open circuit, ideal transformer, dot convention, equivalent circuit of practical transformer, regulation and efficiency from approximate equivalent circuit. Losses in a transformer: calculation of eddy current and hysteresis losses, open circuit and short circuit tests. Parallel operation of single phase transformers. Autotransformer.	**14**
3	**POLYPHASE TRANSFORMERS** Two phase transformations, three phase transformations, transformer connection for three phase circuits using three identical transformers, detailed analysis and operational benefits of different types of three phase transformers :Y-Y, Y-Δ, Δ-Y, Δ-Δ. Open delta and tee-tee connection of transformers, three phase connection for unbalanced loading.	**8**
4	**DC GENERATORS** Generalized singly and doubly excited electromechanical conversion system. DC machines principles and construction: generator action, motor action, commutator, commutation, interpolar and compensating windings, brushes, armature core. Armature windings types, coil pitch, commutator pitch, armature with more segments than slots, dummy elements in wave windings, parallel paths. Armature reaction: magnetizing action of armature currents, armature reaction and flux distribution curve, de-magnetizing and cross magnetizing ampere turns.	**10**

	DC generator: back torque, magnetization characteristics, effect of speed upon voltage, leakage flux, separately and self excited generators, voltage buildup, external characteristics of series, shunt and compound generators, voltage regulation.	
5	**DC MOTORS** DC motor: : back emf, variation of back emf, torque, power developed, armature current with speed for shunt series and compound motors, effect of saturation, speed regulation, starters, speed control of DC motors, braking of DC motors. universal motor.	**7**

List of Experiments:		**Number of Turns**
1	To study various components of DC machine and plot Open Circuit Characteristics	2
2	To obtain performance characteristics of a D.C. Shunt motor.	1
3	To obtain external characteristics of a D.C. shunt generator	1
4	To obtain external characteristics of a D.C. series generator.	1
5	To obtain external characteristics of DC compound generator.	1
6	Speed control of a dc shunt motor by varying armature circuit and field circuit method	1
7	To perform open and short circuit test on a 1-phase transformer and determine a)equivalent circuit b) efficiency	1
8	To determine efficiency and voltage regulation of single phase transformer by direct loading.	1
9	Parallel Operation of two single-phase transformers.	1
10	Three phase to Two phase transformation using Scott Connection.	1
11	To verify voltage and current relationships for different types of three phase transformer connections.	1
12	To obtain performance characteristics of universal motor.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Analyze the evaluate magnetic circuits
2	Students will be able to understand, analyze and evaluate various transformer configurations.
3	Students will be able to understand, analyze and evaluate various types of Dc machines.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Alternating Current Machines by M.G Say, Pitman publishing Ltd	1976
2	Electric Machinery by A.E. Fitzgerald, Charles Kingsley, Jr. and Stephen D. Umans, Tata McGraw-Hill	2013
3	The Performance and Design of Direct Current Machines by Albert E Clayton & N N Hancock, CBS publishers and distributors.	1974
4	Direct Current Machinery by Charles S Siskind, McGraw- Hill book company.	1952
5	Electric Machinery and Transformers by Bhag S Guru &Huseyin R Hiziroglu, Oxford University Press	2000
6	Principles of Electric Machines And Power Electronics by P C Sen, Wiley India	2013
7	Electric Machines by D P Kothari and I J Nagrath, Tata Mcgraw Hill Education Private Limited	2004
8	Electrical Machines by P S Bhimbhra, Khanna Publishers	2011

Course Name	**:**	**ANALOG AND DIGITAL ELECTRONICS**
Course Code	**:**	**EEN-204**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
At the end of this course, the student should be able toinfer transistors and its biasing and how complex devices such as BJT are modeled and the use of the mathematical models in the design and analysis of various circuits such as amplifiers, oscillators and power amplifiers. Also the objective tends to fulfill minimization and designing of various combinational and sequential circuits and principles of Analog and Digital converters.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**TRANSISTOR AND ITS BIASING** Review of diode and BJT, Load line andOperating point, Bias stability, various biasing circuits, Transistor h–parameters, conversion formulas, $r_e$model, and analysis of transistor amplifiers using h-parameters.	5
2	**BJT FREQUENCY RESPONSE** Frequency Response of single stage CE amplifier, Multistage amplifiers, Direct coupled, RC coupled and Transformer coupled, frequency response of multistage amplifiers	5
3	**FIELD EFFECT TRANSISTORS** Introduction, FET Construction, types of FET, Characteristics of FETs, MOSFET: types and working principle, FET biasing, FET small signal model, FET applications.	4
4	**POWER AMPLIFIERS** Classification of amplifiers, Single tuned and double tuned amplifiers, analysis of class A, B, C and AB amplifiers, push pull amplifier, amplitude distortion in amplifiers, harmonics, power distortion,	4
5	**OSCILLATOR** Principle of sinusoidal oscillator, RC phase shift and Wein Bridge oscillator, Collpits and Hartley oscillator, Crystal Oscillator	3
6	**MINIMIZATION TECHNIQUES** Sum of Products and Products of Sum forms, Minterms&Maxterms, Karnaugh Map for two, three, four five and six variables, Quine-McCluskey method	4
7	**COMBINATIONAL CIRCUIT DESIGN** Half adder, full adder, subtractor, BCD adder, comparator, code converter, encoder decoder, multiplexer, demultiplexer, parity detector and generator	4
8	**MULTIVIBRATORS** 1-bit memory cell, clocked and unclocked flip flops, S-R Flip flop, D flip flop, JK Flip flop, T flip flop, edge triggered flip flop, race around condition, Master slave flip flop, conversion of flip flops.	5
9	**SEQUENTIAL LOGIC DESIGN AND SHIFT REGISTERS** Ripple counter, design of Mod-N ripple counter, design of synchronous sequential circuits, State machines, synchronous counter, decade counter, ring counter, Johnson counter, serial in serial out shift register, serial in parallel out shift register, parallel in serial out shift register and parallel in parallel out shift register, bidirectional shift register, universal shift register.	6
10	**A/D AND D/A CONVERTERS** Weighted resistor D/A converter, Binary ladder D/A converter. A/D Converters- flash type, successive approximation, counter ramp type, dual slope type, characteristics of ADC and DAC.	2

List of Experiments:		**Number of Turns**
1	To study the characteristics of BJT and FET.	2
2	To simulateand verify the operation of BJT as an amplifier and draw the frequency response.	2
3	To design, simulate andimplement Adder and Subtractorcircuits.	1
4	To design, simulateandimplement code converters.	2
5	To design, simulate and implement Combinational circuits using Multiplexers.	1

6	To simulate and implement Flip-flops using NAND and NOR Gates.	1
7	To study the operation ofvarios types of shift registers.	2
8	To design, simulate and implement the synchronous sequential circuits.	2

Course Outcomes: By the end of this course, the student will be able to:	
1	Analyze the performance of BJT using small signal analysis.
2	Designing of various types of oscillators.
3	Analyze and designing of sequential and combinational circuits.
4	Design various types of A/D and D/A converters.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Integrated Electronics, Millman&Halkias, TMH.	2008
2	Electronics Devices & Circuit Theory, RL Boylestead& L Nashelsky, PHI	2009
3	Microelectronic Circuits, AS Sedra& KC Smith, OXFORD	2010
4	Electronics Circuit Analysis and Design, Donald A. Neamen, Tata McGraw Hill	2008
5	Digital Design, Morris Mano, PHI, 5th edition	2013
6	Modern Digital Electronics, R P Jain, Tata McGraw HillPublication, 4thEdition	2010

Course Name	**:**	**ENGINEERING ANALYSIS & DESIGN**
Course Code	**:**	**EEN 206**
Credits	**:**	**04**
L T P	**:**	**2-1-2**

Course Objectives:
At the end of this course, the student should have knowledge of fundamentals of design and simulation using software packages.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**MODEL OF PHYSICAL SYSTEMS** Introduction to physical systems, Mass-spring-damper system, accelerometer, rotational mechanical system, gear trains, liquid level systems, circuit models, RL, RC, LC, RLC series and parallel circuits with sinusoidal and non-sinusoidal excitations, diode rectifier.	3
2	**NUMERICAL METHODS FOR SOLUTION OF EQUATIONS** Errors, Systems of linear equations, homogeneous and non-homogeneous linear equations, polynomial equations, least squares fit, ordinary differential equations, Euler's method, Runge-Kutta method, Newton-Raphson method, Predictor corrector methods, numerical integration, forward and backward integration rules. Trapezoidal rule, Simpson's rule, Errors of integration.	9
3	**SIMULATION TECHNIQUES** Continuous state simulation, circuit level simulators, discrete-event simulation, Fixed time step, variable time step, response analysis of circuits, DC analysis, AC analysis, transient analysis.	6
4	**PROGRAMMING IN MATLAB** Programming a function, repetitive and conditional control structures, Iterative solution of equations, polynomial interpolation, plotting and analysis, two-dimensional and three-dimensional plots, Histograms, Polar plots, function evaluation, handling external files, saving and loading data.	4

5	**PSPICE CIRCUIT SIMULATOR** Introduction, circuit descriptions, input files, nodes, circuit elements element values, sources, output variables, analysis, DC sweep, transient and AC analysis, PSPICE models.	3
6	**DESIGN CASE STUDY** DC Motor speed control.	3

List of Experiments:		**Number of Turns**
1	To simulate DC transients in RL, RC and RLC circuit	2
2	To simulate AC transients in Rl, RC and RLC circuit and study effect of switching instant.	2
3	To simulate a DC motor	1
4	To simulate a DC motor with starter	1
5	To design and simulate a transformer	2
6	To simulate a DC Generator	1
7	To design and simulatean air-core inductor	2
8	To simulate a single core cable	1
9	To simulatewave propagation on transmission line	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Model a given physical system
2	Apply numerical methods for solution of linear system of equations
3	Apply numerical methods for solution of differential equations
4	Apply numerical methods for solution of Integral equations
5	Analyse D.C circuits using simulation techniques
6	Analyse A.C circuits in steady state and transient state using simulation techniques
7	Have basic knowledge of MATLAB and PSPICE software
8	Design a speed controller for DC Shunt Motor

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	An Introduction to Numerical Analysis, Atkinson, John Wiley	1989
2	MALLAB 5 for Engineers, Biran A. and Breiner M., 2nd edition, Addison Wesley	1999
3	SPICE for Power Electronics and Electric Power, Rashid M.H. and Rashid H.M., 2nd edition, Taylor & Francis.	2009
4	Introduction to MATLAB for Engineers William J.P., 3rd edition, McGraw Hill.	2010

Course Name	**:**	**POWER ELECTRONICS**
Course Code	**:**	**EEN 207**
Credits	**:**	**04**
L T P	**:**	**3-0-2**

Course Objectives:
By the end of this course, the students should be able to have knowledge of various power electronic devices, switching transients and snubber circuits and analyze various types of AC-DC, DC-DC, DC-AC, AC-AC conversion using power electronic converters.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**POWER ELECTRONIC DEVICES**	5

	Introduction to power switching devices, basic structure and physics of device operation, switching and I-V characteristics (diodes, thyristors, GTO, BJT, Power MOSFET, IGBT). Series and parallel operation of thyristors.	
2	**PRACTICAL CONVERTER DESIGN CONSIDERATIONS** Snubber Circuits: Function and type of snubber circuits, Turn off, turn on and Overvoltage Snubbers. Gate and Base Drive Circuits: Trigger techniques, optical isolators, protection circuits, isolation transformers.	3
3	**AC- DC CONVERSION CIRCUITS** Introduction to Power Processing, Principles of Steady State Converter Analysis: Inductor volt-second balance, Capacitor Charge Balance and Small Ripple Approximation. Line Commutated Rectifiers: Natural Commutation of SCRS, 1ø and 3ø half and fully controlled rectifier configurations with R, L, RL and RLE load. Continuous and Discontinuous Conduction Mode. Output Voltage and Source Current Analysis (THD, DPF, PF).	8
4	**CHOPPER CIRCUITS** Types of chopper: step up, step down. Different classes of chopper circuits: Class A, B, C, D, E. for R, R-L and RLE load. Types of commutation circuits.	4
5	**DC-DC SWITCH MODE CONVERTERS** Introduction to DC-DC Converters, Control of DC-DC Converters, Buck Converter, Boost Converter, Buck-Boost Converter, Cuk Converter, Full Bridge DC-DC Converter. Forward, Push-Pull and Fly back converters. Comparison of DC-DC Converters.	7
6	**AC VOLTAGE CONTROLLERS** Basic Principle, Analysis of 1Ø operation with R and RL Load, Load and Supply Current Characteristics. 3Ø Fully and Half controlled Regulator: Analysis of operation for R and RL Load (various modes of operation). Load and Supply Current Characteristics.	4
7	**DC-AC CONVERSION** 1- Ø and 3- Ø bridge inverters, Voltage Control of Three Phase Inverters: Sinusoidal PWM, 60 Degree PWM, Third Harmonic PWM and Space Vector Modulation (SVM). Relationship between PWM and SVM. Comparison of Various PWM Techniques. Methods of Harmonic Reduction.	7
8	**CYCLOCONVERTORS** Basic Operational features and Operating Principles. Mathematical Representation (output voltage and Input Current) of Static Frequency Changers. Synthesis of the Output Voltage Waveform.	4

List of Experiments:		**Number of Turns**
1	To obtain V-I characteristics of SCR and measure latching and holding currents.	1
2	To obtain triggering wave forms of SCR using R and RC firing circuit.	1
3	To obtain output voltage waveforms of single phase half wave controlled rectified for R-L load.	1
4	To obtain output voltage waveforms for single phase (i) fully controlled (ii) half controlled bridge rectifiers with resistive and inductive loads.	1
5	To obtain output voltage waveforms of single phase ac voltage regulator with R-L load.	1
6	To study different types of chopper circuit and obtain waveform of class C chopper circuit.	1
7	To simulate single phase fully controlled bridge rectifier and draw load voltage and load current waveform for inductive load.	2
8	To simulate single phase full wave ac voltage controller and draw load voltage and load current waveforms for inductive load.	2
9	To simulate single phase inverter using different modulation techniques and obtain load voltage and load current waveform for different types of loads.	3

Course Outcomes: By the end of this course, the student will be able to:	
1	Analyze various power electronic devices, switching transients and snubber circuits.
2	Analyze and evaluate various types of AC-DC, DC-DC, DC-AC, AC-AC conversion using power electronic converters.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Guy Seguier, Christian Rombaut and Robert Bausiere "Power electronic Converters: Volume 2 AC-AC Conversion", North Oxford Academic Publishers	1987
2	B.R.Pelly, "Thyristor Phase Controlled Converters and Cycloconverters", John Wiley and sons	1971
3	L Gyugyi and B.R.Pelly, "Static Power Frequency Changers", John Wiley and Sons,	1976
4	Doebeling, E.O., : Measurement Systems- Application and Design, McGraw Hill Publishing Company	1990
5	R.S.Ramshaw, "Power Electronic Semiconductor switches", Chapman and Hall,	1994
6	R.W.Erickson and Dragan Maksimovic, "Fundamentals of Power Electronics", KLUWER Academic Publishers,	2004
7	M H Rashid, "Power Electronics: Circuits, Devices and Applications", 3rd Edition, Prentice Hall of India Pvt Ltd,	2004
8	N Mohan, T.M. Undeland and W.P.Robbins, "Power Electronics: Converters applications and design", John Wiley and sons	2006
9	Marian K Kazimierczuk, "Pulse-width Modulated DC–DC Power Converters", John Wiley and Sons	2008

Course Name	**:**	**MICROPROCESSORS AND PERIPHERAL DEVICES**
Course Code	**:**	**EEN 208**
Credits	**:**	**4**
L T P	**:**	**3-0-2**

Course Objectives:

At the end of the course, the students should be able to

1. Explain the architecture of 8086 microprocessor
2. Enhance the programming techniques
3. Demonstrate various interfacing techniques.
4. Design a microprocessor based application

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**MICROPROCESSOR 8086** Introduction to Microprocessors and Microcomputers, 8086 Microprocessor architecture, Pin configuration, Register organisation of 8086, physical memory organisation, General bus operation, Special processor activities, Minimum Mode 8086 System and Timings, Maximum Mode 8086 System and Timings.	8
2	**INSTRUCTION SET AND ASSEMBLER DIRECTIVES** Machine Language Instruction Formats, Addressing Modes of 8086, Instruction Set of 8086, , Data transfer, Arithmetic, Branch, loop, machine control, logical, shift and rotate instructions, I/O Assembler Directives and Operators.	9
3	**ASSEMBLY LANGUAGE PROGRAMMING WITH 8086** Machine Level Programs, Programming with an Assembler, Assembly Language Example Programs.	4
4	**SPECIAL ARCHITECTURAL FEATURES AND RELATED PROGRAMMING:** Introduction to stack, stack Structure of 8086, Interrupts and Interrupt Service Routines, Interrupt Cycle of 8086, Non Maskable Interrupt, Maskable Interrupt, Interrupt Programming, .	6
5	**BASIC PERIPHERALS AND THEIR INTRFACING WITH 8086**	7

	Memory interfacing, Programmable Interval Timer (8253/8254), Programmable Interrupt Controller (8259), Keyboard/Display Controller (8279), , DMA Controller (8237/8257). Interfacing I/O Ports, PIO 8255 (Programmable Input-Output Port), Operation of 8255, Interfacing Analog to Digital Data Converters, Interfacing Digital to Analog Data Converters.	
6	**SPECIAL PURPOSE PROGRAMMABLE PERIPHERAL DEVICES AND THEIR INTERFACING**: Programmable Interval Timer 8253, Introduction to Serial Communication, Programmable Communication Interface 8251.	5
7	**MICROPROCESSOR APPLICATIONS** –Stepper motor control, Temp. Control.etc	3

List of Experiments:		**Number of Turns**
1	To study and interface 8255 chip with 8088/80x86/Pentium Trainer system.	1
2	To study and interface 8251 chip with 8086/8088/80x86/Pentium Trainer system.	1
3	To study and interface 8259 chip with 8086/8088/80x86/Pentium Trainer system.	1
4	To interface and control a stepper motor using the stepper motor controller card and stepper motor drives.	1
5	To acquire a unipolar analog signal and convert it into a digital value using A/D Card.	1
6	To acquire a bipolar analog signal and convert it into a digital value using A/D Card.	1
7	8086 based experiments for data transfer operations.	1
8	8086 based experiments for arithmetic operations.	1
9	8086 based experiments for logical operations.	1
10	8086 based experiments for sorting.	1
11	8086 based experiments for data conversions.	1
12	8086 based experiments for interfacing various add on cards	2

Course Outcomes: By the end of this course, the student will be able to:	
1	Explain the functioning of microprocessor.
2	Do projects based on interfacing.
3	Enhance the programming skills.
4	Identify the importance of Assembler Directives and Operators

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Advanced Microprocessors & peripherals by A K Ray & K M Bhurchandi, TMH Publication.	2013
2	Intel Microprocessors by- Berry B.Brey, Printance Hall.	2009
3	Microprocessor & Interfacing by Douglas V Hall, TMH Publication	2006
4	Microcomputer Systems: 8086/8088 Family Architecture, Design and Programming, Chen Liu and Glenn A Gibson, Pearson Education Limited.	2009

Course Name	**:**	**ELECTRICAL MACHINES - II**
Course Code	**:**	**EEN 209**
Credits	**:**	**04**
L T P	**:**	**3-0-2**

Course Objectives:
At the end of this course, the student should be able to have knowledge of constructional features, principle of operation of various types of rotating AC machines and evaluate their performance in motoring and generating mode.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**THREE PHASE INDUCTION MACHINES** General construction features, rotating field theory, per phase & approximate equivalent circuit, production of torque, slip, torque speed characteristics, max power and max torque criterion, maximum efficiency criterion, no load and blocked rotor test to determine performance parameters, circle diagram. Starting: rotor rheostat starter, reduced voltage starting, star delta starting. Deep bar and double cage rotor. Speed control: pole changing, line voltage control, line frequency control, constant slip frequency operation, constant flux operation, rotor resistance control, slip energy recovery, injection of emf in the rotor circuit. Braking: Regenerative, plugging, dynamic braking. Physical phenomenon: Time and space harmonics, cogging, crawling, locking, noise, voltage ripples. Induction generator.	12
2	**SYNCHRONOUS GENERATORS** Construction features, armature windings, pitch and distribution factor, winding connections, induced emf equation, equivalent circuit, synchronous and leakage reactance, cylindrical rotor machine performance with constant synchronous reactance, armature reaction, vector diagram, generator external characteristics and voltage regulation, generator excitation for constant voltage, direct and quadrature axis synchronous reactance, vector diagram, unsaturated and saturated synchronous reactance, open circuit and short circuit characteristics, potier triangle, calculation of saturated synchronous reactance from open circuit saturation curve, determination of direct and quadrature axis synchronous reactance. Efficiency, losses in synchronous generator, power angle, transient and subtransient reactance, determination of transient, subtransient reactance, parallel operation of synchronous generators, synchronizing power, negative and zero sequence impedances of synchronous generator	15
3	**SYNCHRONOUS MOTORS** Construction and operation of synchronous motor, V curves and inverted V Curves, effects of armature reaction, vector diagrams, effect of change in load and field excitation, vector diagram for salient pole synchronous motor, calculation of field current and efficiency, relation between power developed and power angle, electromagnetic power in salient and cylindrical rotor motor, condition for maximum power, maximum power versus power angle, field excitation versus power angle, hunting, damping, methods of starting of synchronous motor, power factor correction using synchronous condensers, hunting.	10
4	**SINGLE PHASE INDUCTION MOTORS** Double revolving field theory, analysis of single phase induction motor, equivalent circuit diagram, torque speed characteristics, types of single phase induction machines, shaded pole motors.	5

List of Experiments:		Number of Turns
1	To perform open circuit test and block rotor test on a 3 phase IM to draw equivalent circuit.	1
2	Determination of the performance characteristics of a three-phase induction motor by load test.	1
3	To obtain a circle diagram of the given three-phase induction motor by conducting no load and blocked motor test and to determine the maximum torque, maximum power output.	1
4	To perform Speed control of three phase Induction Motor using various methods.	2
5	To synchronize an alternator to an infinite bus.	1
6	Variation in the active and reactive power of an alternator connected to an infinite bus by (a) Varying excitation, (b) varying Mechanical-power input.	1
7	To obtain the power angle characteristics of a two generator system.	1
8	To determine the voltage regulation of the given alternator at specified loads by different methods.	1
9	To predetermine the efficiency of an alternator at rated load and power factor and to verify the same by actual load test.	2

10	To perform the slip test to determine Z_d and Z_q, and hence to draw the power angle characteristics of the machine.	1
11	To Plot V and inverted -V curves of Synchronous Motor.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Have knowledge of construction and principle of operation of synchronous machines and induction machines.
2	Analyze and evaluate the performance of induction and synchronous machines in motoring and generating mode.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Alternating Current Machines by M.G Say, Pitman publishing Ltd	1976
2	Electric Machinery by A.E. Fitzgerald, Charles Kingsley, Jr. and Stephen D. Umans, Tata McGraw-Hill	2003
3	Principles of Alternating Current Machinery by Ralph R Lawrence, McGraw- Hill book company.	2010
4	Electric Machinery and Transformers by Bhag S Guru & Huseyin R Hiziroglu, Oxford University Press,	1988
5	Principles of Electric Machines And Power Electronics by P C Sen, Wiley India,	2007
6	The performance and design of alternating current machines by M G Say, CBS publishers.	1976
7	Electric Machines by D P Kothari and I J Nagrath, Tata Mcgraw Hill Education Private Limited.	2006
8	Electrical Machines by P S Bhimbra, Khanna Publishers.	2011

Course Name	**:**	**CONTROL SYSTEM**
Course Code	**:**	**EEN 210**
Credits	**:**	**04**
L T P	**:**	**3-0-2**

Course Objectives:
At the end of the course, the student should be able to model, analyze and design control systems using different methods.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Open loop and closed loop control systems, feedback, effects of feedback, linear and non linear control systems, block diagrams, some examples.	3
2	**MODELING** Modeling of physical systems e.g. electrical, mechanical, translational, rational, thermal systems, electrical, mechanical analogies. Laplace transform, transfer function, block diagram algebra, signal flow graphs, characteristic equation, control system components, error detectors potentiometer, synchros, stepper motor, ac and dc tachogenenrators.	08
3	**TIME DOMAIN ANALYSIS** Importance of time response in transient and steady state analysis, typical test input signals, transient response of the first order, second order system, Time response specifications, and dominant closed loop poles of higher order systems, steady state error and error coefficients.	6
4	**STABILITY**	2

	Concepts of absolute and relative stability, pole zero location, Routh Hurwitz criteria.	
5	**ROOT LOCUS TECHNIQUE** Introduction, root locus concept, construction root loci, stability analysis.	4
6	**FREQUENCY RESPONSE** Introduction and importance of frequency response, Bode diagram, polar plots, log magnitude vs. phase plot, Nyquist stability criterion, stability analysis, relative stability, gain margin & phase margin, closed loop frequency response.	7
7	**INTRODUCTION TO DESIGN** Necessity of compensation, lag and lead compensation, PID Controller.	7
8	**STATE SPACE ANALYSIS** Concept of State, state variable and state vector, state transition matrix, controllability and observability, solution of state equation.	5

List of Experiments:		**Number of Turns**
1	To simulate time response of first order and second order systems for step input.	1
2	To simulate P, PI and PD controller for first and second order system	2
3	To simulate PID Controller for first and second order system.	1
4	To design lag, lead and lag-lead compensators using Bode plot.	1
5	To study DC motor position control system.	2
6	To study synchro-transmitter and receiver and obtain output versus input characteristics.	1
7	Design of lag-lead compensators.	1
8	To obtain time responses of first and second order system for step input.	1
9	To draw Nyquist plot of open loop transfer functions and examine the stability of the closed loop system.	2
10	To obtain the frequency response for first and second order system.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	acquire knowledge of control systems.
2	model and analyze physical systems for controlling their responses.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Control Systems Engineering, I.J.Nagrath and M.Gopal, Wiley Eastern	2008
2	Modren Control Engineering, K. ogata, PHI	2009
3	Automatic Control systems, B.C Kuo	2009

Course Name	**:**	**COMPUTER AIDED POWER SYSTEM ANALYSIS**
Course Code	**:**	**EEN 301**
Credits	**:**	**04**
L T P	**:**	**3-0-2**

Course Objectives:
At the end of the course the student should be able to: Model and analyze the power systems under steady state and abnormal conditions. Apply numerical methods to solve the power flow problem. Model and analyze the transient behavior of power system when it is subjected to a fault.

Total No. of Lectures – 42

Lecture wise breakup	**Number of**

		Lectures
1	**INTRODUCTION** Single line diagram of power system, modeling of synchronous machines, transformer loads, transmission line etc., per unit representation of power system.	3
2	**POWER FLOW STUDIES** Formation of Z-bus & Y-bus matrices, power flow problem, power flow solution by Gauss-Siedel, Newton Raphson and fast decoupled methods, algorithm and flowchart, Comparison of the three methods. Load frequency control. Economic operation of generators. Power flow studies using software.	10
3	**SHORT CIRCUIT STUDIES** Symmetrical (or) balanced three phase faults, Symmetrical components, positive sequence, negative sequence and zero sequence networks of electrical appliances and power system, inter connection of sequence Networks for three phase single line to ground, line to line, double line to ground and open conductor faults. Fault calculation using software.	10
4	**ECONOMIC LOAD DESPATCH** Introduction, Optimal Operation of Generators of Bus bar, Unit Commitment, Optimal Generation Schedule, Hydro thermal optimal scheduling, Economic dispatch without line losses, economic dispatch with line losses, lambda iteration method, gradient method, Newton's method, base point and participation factors.	10
5	**STABILITY ANALYSIS** Stability Analysis: steady state, Transient stability, Dynamic stability, Rotor dynamics and swing curve, Swing curve equation representation with different units, Equal area criteria and its applications with different cases, Step by step method of analysis of transient stability, Factors affecting transient stability, Role of AVR on transient stability of system, Numerical methods of transient analysis. Fundamentals of Voltage Stability.	9

List of Experiments:		**Number of Turns**
1	To compute Z-Bus impedance matrix of a multibus power system network using step by step method.	1
2	To compute Y-Bus Admittance matrix of a multibus power system network using Nodal method.	1
3	To compute Unsymmetrical fault in a multi-bus power system using software for different types of fault conditions.	2
4	To develop computer code for Load Flow study of power system using Gauss-Siedal method.	2
5	To develop computer code forLoad Flow study of power system using Newton-Raphson method.	2
6	To develop computer code for Load Flow study of power system using Fast-Decoupled method.	2
7	To simulate single machine infinite bus system incorporating the line opening and closing, or fault removal features, for transient stability studies	2
8	To simulate Load-Frequency Control of single area network.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Students will be familiar with the modeling of power system and components.
2	The students can solve power flow problems and control of power flow.
3	Students will be able to model and analyze power system under abnormal conditions
4	Importance of stability analysis in power system planning and operation
5	The students will be capable of working in real power systems under normal and abnormal conditions.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Power System Analysisby J.J. Grainger and W.D. Stevenson, McGraw Hill Int. Student Ed.	2003

2	Modern Power System Analysisby I.J.Nagarath& Kothari, McGraw Hill Int. Student Ed.	2011
3	Power System Analysis by T.K.Nagasarkar and M.S. Sukhija Oxford University Press, 2007.	2007
4	Computer Methods in Power Systems by G W Stagg.	2010
5	Power System Analysis by Hadi Saadat.	2013

Course Name	**:**	**SWITCHGEAR AND PROTECTION**
Course Code	**:**	**EEN 302**
Credits	**:**	**04**
L T P	**:**	**3-0-2**

Course Objectives:
At the end of this course the student should be able to: Have knowledge of the concept and necessity of protection in generation and transmission and applications of switchgears including internal operation of different types of circuit breakers.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**BUS BAR ARRANGEMENTS, ISOLATING SWITCHES** Function, types, operation and rating, Main equipment in substation; substation layout, Different Bus bar schemes	3
2	**FUSES** Types, ratings, theory and characteristics, construction, characteristics and applications of HRC fuses.	3
3	**Principles Of Circuit Interruption** Principles of arc suppression in d.c. and a.c. circuits. Recovery and Rest Rising Voltage (RRRV); causes of switching surges.	4
4	**CIRCUIT BREAKERS** Classification of circuit breakers, construction, operation & applications of minimum oil, bulk oil, air break, air blast and SF_6 circuit breakers; rating and maintenance of circuit breakers; operating mechanisms of circuit breakers, vacuum circuit breakers.	4
5	**RELAYS** Constructional features and characteristics to electro-magnetic induction and thermal relay, over current, directional over current, reverse power, percentage differential, impedance, mho, reactance and negative sequence relays, static relays.	4
6	**PROTECTIVE EARTHING OBJECTS** Earthing resistance of hemispherical and single driven rod, earthing arrangements; different types of neutral earthing, calculation of neutral shift, Earthing of substation equipments.	3
7	**PROTECTION OF FEEDERS** Time graded over current protection for radial, parallel & ring feeders; circulating current and balanced voltage protective schemes; Distance protection of feeders – Application of impedance, reactance and mho relay, elementary ideas about carrier, current protection of transmission lines, Numeric relays.	5
8	**GENERATOR PROTECTION** Types of faults on stator and rotor; stator & rotor protection; negative sequence protection; loss of excitation & overload protection.	4
9	**TRANSFORMER PROTECTION** Power transformer protection: Differential protection and magnetic balance protection, Restricted earth fault protection, Buchholz relay, Protection of combined alternator and transformer.	5
10	**PROTECTION AGAINST OVERVOLTAGES** Ground wire, shielding angle rod gap, horn gap, impulse gap, valve type and non-linear arresters surge absorbers.	2

11	**OVER VOLTAGE PHENOMENON, PROTECTION & INSULATION CO-ORDINATION** Theory of physics of lightning flashes & strokes. Insulation co-ordination, Volt-time and circuit time characteristics. Horn gap, Single diverters, Ground wires, Surge absorbers	3
12	**MICROPROCESSOR BASED PROTECTION** Introduction to microprocessor based relays & digital relays.	2

List of Experiments:		**Number of Turns**
1	To measure Symmetrical fault level measurement on a dc network analyzer	1
2	To measure Unsymmetrical fault level measurement on a dc network analyzer for various types of faults	2
3	To measure ground resistivity and resistance of a ground electrode	1
4	To plot inverse definite minimum time characteristics of numerical over current relay.	1
5	To plot inverse definite minimum time characteristics of numerical Earth fault over current relay.	1
6	To study and analyze transformer protection using differential relay for in zone trip faults.	1
7	To plot characteristics of percentage bias differential relay.	1
8	To study and analyze the performance of distance protection	1
9	To perform pick up test for differential relay.	1
10	To study and analyze the performance of Merz-price protection for a three phase alternator.	2
11	To plot inverse definite minimum time characteristics of directional over current relay.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Design the relevant protection systems for the main elements of a power system.
2	Analyze over current, differential, radial protection devices and their application in a coordinated protection scheme.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	M.L. Soni, P.V. Gupta, V.S. Bhatnagar, A. Chakrabarti, 'A Text Book on Power System Engineering', DhanpatRai& Co.	2009
2	Power Systems Analysis by C L Wadhwa, Wiley India Ltd.	2009
3	S.S. Rao, Switchgear and Protection, Khanna Publishers, Delhi	2008
4	Protective Relaying: Principles &Applicationsby Blackburn J L and Domin T J, , CRC Press	2010

Course Name	**:**	**ELECTRIC DRIVES**
Course Code	**:**	**EEN 303**
Credits	**:**	**05**
L T P	**:**	**3-1-2**

Course Objectives:
At the end of the course, the student should be able to model AC and DC machine in generalized framework and use it to control the machine using power electronic converter.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**MODELING OF DC MACHINE** Kron's Primitive Machine Model (Two Axis Model), statically induced EMF, Rotational or	10

	Dynamically Induced EMF, Generalized Torque Expression of Kron's Primitive machine. Mathematical model of DC machine (shunt, series, separately excited), steady state characteristics with armature and field control, dynamic behavior with constant flux,	
2	**POWER ELECTRONICS CONTROLLED DC DRIVES** Static convertor as power actuator for DC drives: single and three phase drives, convertors with reduced reactive power, power factor improvement techniques, control loop containing electronics power converters. Control of converter supplied DC drives, braking operation using power electronics converters.	12
3	**MODELING OF INDUCTION MACHINE** Modeling of three phase Symmetrical Induction Machines (IM) in abc variables, Co-Energy and Torque Expression. d-q (Transformation) Modeling of symmetrical 3 phase Induction Machine, Rotor Transformation, Torque expression in d-q Frame. Equivalent Circuit.Reference Frame Theory, Power Invariant and Amplitude Invariant Transformation, Stanley Reference Frame, Park Reference Frame, Synchronous Reference Frame and arbitrary Reference Frame. Induction Machine Modeling in Arbitrary Reference Frame	12
4	**VECTOR CONTROL OF INDUCTION MACHINE** Vector Control of Induction Machine: Concept of Space Phasor, Principle of Decoupled Control, Rotor Flux Oriented Vector Control, Stator Flux Oriented Vector Control, Magnetizing Flux Oriented Vector Control. Torque Response. Flux Estimation Schemes.	8

List of Experiments:		**Number of Turns**
1	To obtain the speed control of DC machine using full wave fully controlled thyristorized converter.	1
2	To obtain the speed control of DC machine using first quadrant chopper.	1
3	To obtain four quadrant operation of DC motor using IGBT based DC chopper.	1
4	To obtain speed control performance of induction motor using v/f control.	1
5	To obtain speed control of induction motor using vector control.	2
6	To simulate the speed control of DC machine using full wave fully controlled and semi controlled thyristorized converter and compare various AC and DC side performance parameters.	2
7	To simulate the speed control of DC machine using first quadrant chopper and evaluate the performance using different chopping frequencies.	1
8	To simulate speed control of induction motor using v/f control and obtain dynamic behavior of the machine when changing from one frequency to another.	2
9	To simulate speed control of induction motor using vector control and obtain dynamic behavior of the machine. Also compare the dynamic performance with v/f control.	2

Course Outcomes: By the end of this course, the student will be able to:	
1	Analyze mathematical model of AC and DC machines.
2	Analyze various power electronic controllers for AC and DC drives.
3	Analyze and compare various closed loop control strategies for AC and DC machines.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Werner Leonhard, "Control of Electrical Drives, 3rd edition", Springer,	2001
2	Power Electronics: Converters applications and design by N Mohan, T.M. Undeland and W.P.Robbins, John Wiley and sons 2006,	2006
3	P C Sen, "Thyristor DC Drives", wiley-interscience publication,	1981
4	Ned Mohan, "First Course on power electronics and drives", MNPERE	2011
5	PiotrWach, "Dynamics and Control of Electrical Drives", Springer,	2011

Course Name	**:**	**CAD OF ELECTRICAL MACHINES**
Course Code	**:**	**EEN 304**
Credits	**:**	**04**
L T P	**:**	**3- 0-2**

Course Objectives:
At the end of this course, the student should be able to design and evaluate the performance of rotating machines and transformers.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Basic principles of electrical machine design, .Magnetic circuit calculations, Calculation of leakage reactance parameters, losses, temperature rise .	6
2	**DESIGN OF TRANSFORMERS** Design of single-phase and three-phase transformers-Core design, Windings design, cooling of transformers .Operating characteristics.	12
3	**DESIGN OF ROTATING MACHINES** General concepts and constraints of design of rotating machines. Design of squirrel-cage and wound rotor type of three Phase induction motor. Stator and its windings, slot and its insulation, squirrel - cage and slip-ring rotor design, Operating characteristics	12
4	**COMPUTER AIDED DESIGN OF TRANSFORMER AND ROTATING MACHINES** Computer aided design, philosophy and economics, selection of input data and design variables, flow chart for design of transformer and rotating machines, Application of software for design implementation.	8
5	**OPTIMIZATION TECHNIQUES REVIEW** Objectives and constraint functions, constrained and unconstrained minimization, flow chart development for design optimization of electrical machines.	4

List of Experiments:		**Number of Turns**
1	Winding design and drawing of d.c machine.	2
2	Winding design and drawing of a.c machine	2
3	Computer aided design of a of single phase and three phase transformer	3
4	Computer aided design of induction machine	2
5	Computer aided design of dc machine	2
6	Computer aided design ofsynchronous machine.	2

Course Outcomes: By the end of this course, the student will be able to:	
1	Design transformers and rotating machine and choose various parameters based upon performance analysis
2	Design transformer and rotating machines using software .
3	Apply optimization techniques for computer aided design of electrical apparatus.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	A.K.Sawhney, A course in Electrical Machine Design, DhanpatRai& Sons	2005
2	Say M.G, “The performance and design of AC machines”, CBS publishers and distributors.	2002
3	Veinott C.G, “Computer aided design of electrical machinery”, MIT Press.	1987
4	Sen S.K, “Principle of electrical machine design with computer programs”, Oxford and IBH company Pvt Ltd.	2001

5	Ramamoorthy M, "Computer aided design of Electrical Equipment", East West Press.	2002

Course Name	**:**	**HIGH VOLTAGE ENGINEERING**
Course Code	**:**	**EEN305**
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Course Objectives:
At the end of this course, the student should be able to acquire knowledge of discharge phenomena in solid, liquid and gases and high voltage testing and measurement.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**DISCHARGES IN GASES** General characteristics of gaseous insulation, Basic processes of ionisation in a gas: Discharges in uniform and non-uniform fields; Townsend Mechanism, Townsend first and second ionization coefficients, Paschen's Law; Corona discharges due to direct and alternating voltage. Vacuum breakdown mechanisms. Practical methods of calculating Corona Loss on transmission lines. Commonly used gases for insulation and their properties.	8
2	**BREAKDOWN OF SOLIDS AND LIQUIDS** Basics of solid insulating materials, Types of insulating materials, temperature classification, factors affecting dielectric strength, Different mechanisms of breakdown of solids; intrinsic breakdown; Theories of intrinsic breakdown; Different theories of breakdown in liquids; commonly used solid and liquid insulation materials and their properties.	8
3	**LIGHTNING PHENOMENON** Change accumulation in clouds: formation of lightning stroke; characteristics of lightning stroke; Current and Voltage magnitudes;	5
4	**GENERATION OF AC/DC/IMPULSES** Definition of impulse wave, Generation of high DC, AC impulse voltages and impulse currents; single stage and multi stage impulse generators and equivalent circuits	4
5	**HIGH VOLTAGE MEASUREMENTS** Measurements of A.C., D.C. and Impulse Voltage; Sphere gap, resistance and capacitance potential dividers, Standard capacitors: High Voltage measurements by measuring rectified current of a standard capacitors: Crest Voltmeter, Electrostatic voltmeter. Impulse voltage measurement by Cathode Ray Oscillograph.	6
6	**HIGH VOLTAGE TESTING EQUIPMENT** Power frequency high voltage testing transformer, Cascade connection of transformers. Generation of high direct voltage by voltage doubler circuit and cockrort Walton Circuit.Introduction to nano materials for high voltage engineering.	5
7	**NON-DESTRUCTIVE HIGH VOLTAGE TESTING** H.V. testing of Cables and transformers. Testing of transformer oil for electric strength. General idea about dielectric constant and loss factor. Application of H.V. Schering Bridge for tests.	6

Course Outcomes: By the end of this course, the student will be able to:	
1	Acquire knowledge of the fundamentals of discharge phenomena in solid, liquid and gases.
2	Acquire knowledge of high voltage testing and measurement.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/**

		Reprint
1	C.L. Wadhwa, High Voltage Engineering, 2nd edition, New Age International Ltd.	2006
2	M.S.Naidu and V.Kamaraju, High Voltage Engineering, McGraw-Hill, 3rd edition, .	1995
3	Die Dieter Kind, Kurt Feser, 2nd edition, High Voltage Test Technique	2001
4	E.Kuffel and W.S.Zaengl, High Voltage Engineering Fundamentals, Newness, 2nd edition,	2000
5	Chaurasia M P, High Voltage Engineering, Khanna Publishers	1976

Course Name	**:**	**RESTRUCTURED AND DEREGULATED POWER SYSTEMS**
Course Code	**:**	**EEN 401**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to acquire knowledge of economic issues in power sector, power system de-regulation, restructuring, market reforms, transmission planning and pricing issues.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**POWER SECTOR IN INDIA** Evolution of integrated, monopoly, state electricity boards (SEBs), introduction to various institutions in Indian power sector such as CEA, planning commission, PFC, Ministry of Power, state and central Governments, REC, financial institutions, PTC, utilities and their roles, challenges before Indian power sector, electricity act 2003 and various National policies and guidelines under the act, introduction to Indian Energy Exchange and its working.	5
2	**DEREGULATION OF ELECTRICITY SUPPLY INDUSTRIES** Introduction to deregulation, different entities in deregulated electricity markets, background of deregulation around the world, benefits from competitive electricity markets, different key issues of competitive electricity markets, market Clearing Price(MCP) - Market operations: Day-ahead and Hour-Ahead Markets, Elastic and Inelastic demand, technical challenges, Power System Restructuring and electricity reforms in India, key features of electricity act 2003.	8
3	**MARKET MODELS** Market Models based on energy trading, contractual agreement: Pool & Bilateral models, different independent models, role of ISO, market power, Bidding and auction mechanisms, optimal power flow, economical load dispatch and unit commitment in deregulated environment, market models in Indian market context and power trading in India.	7
4	**TRANSMISSION OPEN ACCESS AND PRICING ISSUES** Power wheeling, transmission open access, cost component in transmission pricing, basic objectives, different methods of transmission pricing, Short run and long run marginal transmission price structure, development in international transmission pricing, reactive power pricing structure, and its calculation for generator's reactive support, numerical examples, impact of FACTS devices on transmission pricing.	7
5	**AVAILABLE TRANSFER CAPABILITY DETERMINATION** Definitions, principles of ATC determination, factors affecting ATC, static and dynamic ATC, static ATC determination using DC power transfer distribution factors, AC power transfer distribution factors, ATC with line outage contingencies, LODFs with DC and AC, dynamic ATC and its determination, ATC enhancement with FACTS controllers, numerical examples.	7
6	**TRANSMISSION CONGESTION MANAGEMENT**	8

	Transmission congestion, impact of transmission congestion, different methods of congestion management, financial transmission right, flow gate rights, market power and congestion issues, numerical examples, international experiences of transmission congestion management, security management: spinning reserves, interruptible load options.	

Course Outcomes: By the end of this course, the student will be able to:	
1	Acquire knowledge of economic issues in power sector, power system de-regulation, restructuring, market reforms, transmission planning and pricing issues.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	LaiLio Lee, Power System restructuring and deregulation. John Wiley and Sons, UK	2012
2	BhattacharyaK, Bollen MHT and DoolderJC, Operation of Restructured Power Systems, Kluwer Academic Publishers, USA	1998
3	ShahidehpourM et al., Market Operations in Electric Power Systems, John Wiley and Sons	2002
4	IlicM, Power Systems Restructuring-Engineering and Economics, Kluwer Int. Series	2008
5	PhilipsonLorrin, WillisH Lee, Understanding electric utilities and de-regulation, Marcel Dekker Pub	2006

Course Name	**:**	**SMART GRID TECHNOLOGIES**
Course Code	**:**	**EEN 402**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to describe the fundamentals of smart grid technologies such as smart measurements, smart technology for smart substations, micro grid and distributed energy sources, power quality management in smart grid, information and communication technology for smart grid.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO SMART GRID** Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid . CDM	6
2	**SMART GRID TECHNOLOGIES: PART 1** Introduction to Smart Meters, Real Time/Dynamic Pricing including ToD pricing, Automatic Meter Reading(AMR), Advanced Metering Infrastructure (AMI), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Smart Appliances and Building Management Systems (BMS), Energy Management Systems (EMS), Customer empowerment and engagement using technology and interactive applications and Business Analytics, Work Force Management and Field Force Automation.	8
3	**SMART GRID TECHNOLOGIES: PART 2** Smart Substations, Substation Automation, Feeder Automation, SCADA, Assessment management through Condition Based Monitoring, Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Grid storage like Battery, / SMES, /Pumped Hydro, / Compressed Air Energy Storage, Thermal Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).	8

4	**MICRO GRIDS AND DISTRIBUTED ENERGY RESOURCES** Concept of micro grid, need & applications of micro grid, formation of micro grid, Issues of interconnection, protection & control of micro grid. Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources, Demand Side Management through Energy Efficient/BEE Rated appliances and Automated Demand Response, Load research, Energy audit tools to save wastage.	8
5	**POWER QUALITY MANAGEMENT IN SMART GRID** Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Volt-Var optimization, Reactive Power Compensation. Asset Optimization using Smart Grid Technologies. Power Management and Management of Peak Load using Smart Grid Technologies	5
6	**INFORMATION AND COMMUNICATION TECHNOLOGY FOR SMART GRID** Home Area Network (HAN), / Neighborhood Area Network (NAN), / Wide Area Network (WAN). Different Communication Technologies and Protocols like Bluetooth, /Zig-Bee, /GPRS, /Wi-Fi, /Wi-Max/RF/PLC based communication, Mesh communication Network etc., Integrated Communication infrastructure with Integrated Network Monitoring System, Advanced Business Analytics, Basics of CLOUD Computing & Cyber Security for Smart Grid, Big Data storage, convergence of Operational technology and information technology, ERP, Significance of Enterprise Service Bus (ESB) to implement SOA, Use of Software as a Service (SaaS) applications	7

Course Outcomes: By the end of this course, the student will be able to:	
1	By the end of this course, the student will be able to analyze smart grid technologies such as smart measurements, smart technology for smart substations, micro grid and distributed energy sources, power quality management in smart grid, information and communication technology for smart grid for further power system applications.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu	2012
2	Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley	2009
3	Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu Akihiko Yokoyama, " Smart Grid: Technology and Applications", Wiley	2001
4	Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell	2012
5	Tony Flick and Justin Morehouse, "Securing the Smart Grid", Elsevier Inc. (ISBN: 978-1-59749-570-7)	2006
6	Peter S. Fox-Penner, "Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities"	2010
7	Akihiko Yokoyama, " Smart Grid: Technology and Applications", Wiley	2012

Course Name	**:**	**SOLAR ENERGY ENGINEERING**
Course Code	**:**	**EEN 403**
Credits	**:**	**4**
L T P	**:**	**3-1/2-2/2**

Course Objectives:

After the end of the course the student should be able to have the knowledge of characteristic of solar radiation, its global distribution and conversion methods of solar energy to heat and power, solar energy storage and software tools for solar system optimization.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO SOLAR ENERGY SOURCES** World energy resources, Indian energy scenario, Environmental aspects of energy utilization. Renewable energy resources and their importance, global solar resources. Solar spectrum, electromagnetic spectrum, basic laws of radiation. Physics of the Sun, energy balance of the earth, energy flux, solar constant for earth, green house effect.	7
2	**SOLAR RADIATION AND MEASUREMENT** Solar radiation on the earth surface, extraterrestrial radiation characteristics, terrestrial radiation, solar isolation, spectral energy distribution of solar radiation. Depletion of solar radiation, absorption, scattering. Beam radiation, diffuse and global radiation. Measurement of solar radiation, pyranometer, pyrheliometer, sunshine recorder. Solar time, local apparent time (LAT), equation of time (E).	7
3	**SOLAR RADIATION GEOMETRY AND CALCULATIONS** Solar radiation geometry, earth, sun angles, solar angles, calculation of angle of incidence, surface facing due south, horizontal, inclined surface and vertical surface. Solar day length, sun path diagram, shadow determination.	5
4	**SOLAR THERMAL ENERGY CONVERSION** Thermodynamic cycles:carnot, organic, reheat, regeneration and supercritical Rankine cycles, Brayton cycle, Stirling cycle, Binary cycles, combined cycles, solar thermal power plants, parabolic trough system, hybrid solar-gas power plants, solar pond based electric power plant, central tower receiver power plant.	7
5	**SOLAR ELECTRICAL ENERGY CONVERSION** Solar photovoltaic energy conversion, principles, physics and operation of solar cells, classification of solar PV systems, solar cell energy conversion efficiency, I-V characteristics, maximum power point, cell efficiency, fill factor, effect of irradiation and temperature, losses, solar PV power plants.	7
6	**SOLAR ENERGY STORAGE** Energy storage - Utilization of energy storage devices, specific areas of applications of energy storage, selection of types of energy to be stored, types of storage system.	4
7	**ENERGY OPTIMIZATION** Overview of effective tools for solar energy systems, case studies ofsolar energy system optimization.	5

List of Experiments:		**Number of Turns**
1	To estimate solar irradiation at a location	2
2	To determine power of standalone PV system of DC load and battery	1
3	To evaluate the effect of variation in tilt angle on PV module Power	1
4	To simulate a standalone PV Solar PV System	1
5	To do techno-economic analysis of standalone Solar PV system using software	2

Course Outcomes: By the end of this course, the student will be able to:	
1	Characteristics and world distribution of solar radiation
2	solar radiation and measurement techniques
3	fundamentals of thermal and direct conversion of solar energy to power.
4	software tools to solve for energy system optimization.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Foster R.Ghassemi M., Cota A., “Solar Energy”, CRC Press.	2010

2	Garg H.P., Prakash J., "Solar Energy Fundamentals and Application", Tata McGraw Hill.	2005
3	S.P.Sukhatme, "Solar Energy" Tata McGraw Hill Publishers	1997
4	Kalogirou S.A., "Solar Energy Engineering Processes and Systems", Academic Press.	2009
5	Yogi Goswami D., Frank Kreith, Jan F.Kreider, "Principles of Solar Engineering", Taylor & Francis	2003 (2nd edition)

Course Name	**:**	**BIOMEDICAL ENGINEERING**
Course Code	**:**	**EEN 404**
Credits	**:**	**4**
L T P	**:**	**3 -1/2- 2/2**

Course Objectives:
At the end of this course, the student should be able to acquire knowledge of various types of instruments used in Biomedical Engineering.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO BIO INSTRUMENTATION** Problems encountered in measuring a living system, Electric shock Hazards, safety codes for electro-medical equipment.	3
2	**SOURCES OF BIOELECTRIC POTENTIALS** Resting and action potentials, propagation of action potential, the bioelectric potential-with special reference to ECG, EEG and EMG.	5
3	**ELECTRODES** Recording electrodes, electrical conductivity of electrodes, jellies and creams	3
4	**TRANSDUCERS IN MEDICAL EQUIPMENTS** Displacement, pressure, body temperature measurement, photoelectric transducers optical fibre sensors	4
5	**BIOMEDICAL RECORDERS** Electrocardiograph, electroencephalograph, electro-myograph Biofeedback instrumentation.	4
6	**PATIENT MONITORING SYSTEM** System concepts, cardiac monitor, bedside patient monitoring system, measurement of heart rate, pulse rate, blood pressure measurement, temperature, respiratory rate, catheterization of laboratory instrument.	4
7	**METHODS OF HEATING TISSUES** Physiological effect of heat, short wave diatherapy, infra-red radiation, microwave diathermy, surgical diathermy.	3
8	**BIOMEDICAL TELEMETRY AND TELEMEDICINE** Introduction and application to Biomedical Engineering.	3
9	**MODERN IMAGING SYSTEM** Computed tomography, magnetic resonance imaging system, thermal camera based on IR sensors, Image Reconstruction techniques.	8
10	**THERAPEUTIC EQUIPMENTS** Pacemakers, cardiac defibrillators, pain relief through electrical stimulation, Haemodialysis machine, electronics in anaerhetic machine	5

List of Experiments:		**Number of Turns**
1	To study the ECG machine, pick up ECG signal, display it on CRO and to find theduration of P, R and T Wave.	2
2	To plot experimentally the relationship b/w the surface EMG and muscular force.	1

3	To pick up EEG signals and study their patterns.	2
4	To study an MRI system available in the field.	1
5	To study the frequency spectrum of EMG on a display devices using a moveable band pass filter.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Acquire knowledge of biomedical instruments, analysis of different signal, Telemetry and Telemedicine.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	John G. Webster, Bioinstrumentation, John Wiley & Sons	2004
2	Leslie Cromwell, Fred J. Weibell & Erich A Pfeiffor, Biomedical Instrumentation and Measurements, 2nd edition, PHI	2001
3	Khandpur, Handbook of Biomedical Instrumentation, 2nd edition, TMH	2003

Course Name	**:**	**NEURAL NETWORKS AND FUZZY SYSTEMS**
Course Code	**:**	**EEN 411**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to acquire knowledge of neural networks and fuzzy systems, different structure of neural networks, development and implementation of algorithm, and their applications. Design neural networks and fuzzy systems for different applications.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Biological neuron, Models of Artificial Neural Networks (ANN), Characteristics of Neural Networks, Different types of learning of neural network.	4
2	**FUNDAMENTAL MODELS OF ANN** Mcculloch–Pitts, Hebbian, Perceptron, Delta, Owstrar, Boltzman, Adaline, Madaline: Architecture, Algorithm and Applications.	5
3	**FEED FORWARD NETWORKS** Back propagation, Radial basis function- Architecture, Algorithm and Applications.	4
4	**SELF ORGANIZING FEATURE MAP** Kohonen Self Organizing Maps, Learning Vector Quantization (LVQ), Max. Net, Hamming Net-Architecture, Algorithm and Applications.	4
5	**FEEDBACK NETWORKS** Hopfield Net- Architecture, Training Algorithm and Application for discrete and continuous net.	3
6	**ASSOCIATIVE MEMORY NETWORKS** Hetero, Auto and Bi-directional Associative Networks-Architecture, Algorithm and Applications.	3
7	**APPLICATION OF NEURAL NETWORKS** Application of neural network in engineering areas.	3
8	**INTRODUCTION OF FUZZY SYSTEMS** Fuzzy logic, classical sets and fuzzy sets, operations on fuzzy sets, properties of fuzzy sets, crisp and fuzzy relations, membership functions, fuzzification, defuzzification.	9

9	**FUZZY RULE BASED SYSTEM** Formation of rules, decomposition of rules, aggregation and properties of fuzzy rules, fuzzy inference system.	4
10	**APPLICATIONS OF FUZZY LOGIC** Fuzzy logic applications in various areas including power systems, image processing, control systems, industries etc.	3

Course Outcomes: By the end of this course, the student will be able to:	
1	Apply the concepts and rule based fuzzy logic system, design and implementation of fuzzy logic controllers in engineering areas.
2	Have knowledge of concepts, different structure design, implementation of algorithm, and applications of neural networks.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Fundamental of Neural Networks-Architectures, Algorithm and Applications by Laurene Fausett, Pearson,.	1993
2	Neural Networks- A comprehensive foundation bySimon Haykin, Macmillan Publishing Company, New York,.	1994
3	Neural Networks-A classroom approach by Satish Kumar, The McGraw-Hill Companies,.	2005
4	Fuzzy Logic with Engineering Applications by Timothy J. Ross Wiley Student Edition,.	2010
5	Introduction to Neural Networks using MATLAB by S.N.Sivanandam, S. Sumati and S.N.Deepa, Tata McGraw Hill,.	2006
6	Introduction to Fuzzy Logic using MATLAB by S.N.Sivanandam, S. Sumati and S.N.Deepa, Springer,.	2007

Course Name	**:**	**ADVANCED CONTROL SYSTEMS**
Course Code	**:**	**EEN 412**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to acquire knowledge of state variable analysis and design, digital and optimal control, neural network of fuzzy systems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**STATE VARIABLE ANALYSIS AND DESIGN** Introduction, Concepts of State, State Variables and State Model, State Models for Linear Continuous-Time Systems, state variables and linear discrete- time systems, diagonalization, Solution of State Equations, Concepts of Controllability and Observability, Pole Placement by State Feedback, Observer Systems.	13
2	**INTRODUCTION OF DIGITAL CONTROL** Digital control systems: advantages and disadvantages of digital control, representation of sampled process, the z-transform, the z-transfer function. the inverse, -transform and response of linear discrete systems, the z-transform analysis of sampled-data control systems, the z-and s-domain relationship, stability analysis.	12
3	**OPTIMAL CONTROL SYSTEMS** Introduction, parameter optimization: servomechanisms, optimalcontrol problems: state	9

	variable approach, the state regulator problem, the infinite-time regulator problem, the output regulator and the tracking problems.	
4	**NEURAL NETWORKS AND FUZZY SYSTEMS** Introduction to neural networks and fuzzy systems, intelligent control, models of neural networks and fuzzy systems.	8

Course Outcomes: By the end of this course, the student will be able to:	
1	Acquire knowledge of state variable analysis and design.
2	Acquire knowledge of digital and optimal control systems.
3	Acquire knowledge of neural network and fuzzy systems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	M.Gopal, Modern Control System Theory, New Age Intl. Pvt. Ltd.	1993
2	M.Gopal, Digital Control State variable methods, TMH.	2003
3	K. Ogata, Modern Control Engineering, PHI	2010
4	K.Ogata, Discrete Time Control Systems, PHI	1995

Course Name	**:**	**POWER SYSTEM OPERATION AND CONTROL**
Course Code	**:**	**EEN 413**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to acquire knowledge of the economic load dispatch, unit commitment, power system operational security and dispatch.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**ECONOMIC DISPATCH** Economic dispatch of hydro, thermal, hydro-thermal generating units, dispatch problem solution methods (any two), economic dispatch with & without transmission line losses. Base point and participation factors, penalty factors.	6
2	**FREQUENCY CONTROL AND AGC** Review of theory of frequency dynamics. Multi-area frequency dynamics. Load-frequency and tie-line power flow control. Theory of Automatic Generation control, AGC implementation methods.	9
3	**UNIT COMMITMENT** Introduction, constraints, Priority lists, Integer Programming, Dynamic Programming, Lagrangian Relaxation and Neural Net Methods.	6
4	**INTERCONNECTED SYSTEMS OPERATION** Need of system interconnection. Operating policies. Economic interchange. Optimal multi-area Operation.	5
5	**ENERGY MANAGEMENT SYSTEMS AND REAL-TIME CONTROL** Energy management systems, Software systems, Computer hardware resources and configurations. Data management. Communications and distributed computing. Expert systems for contingency and security evaluation, event analysis, system restoration and reactive control. Short range load forecasting, SCADA.	9
6	**POWER SYSTEMS OPERATIONAL SECURITY AND DISPATCH**	7

	Review of security concept and state of operation, contingency analysis; generation dispatch; dynamic security; power system state estimation; maximum likelihood weighted least-squares estimation; and measurements; network observabilities and pseudo-measurements; applications in system control.	

Course Outcomes: By the end of this course, the student will be able to:	
1	Acquire knowledge of the Economic load dispatch and frequency control.
2	Acquire knowledge of the interconnected system operation, energy management and power system operational security.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Wood and Wollenberg "Power Generation Operation and Control", John Wiley.	1984
2	OI Elgerd "Electric Energy Systems, Theory", McGraw Hill	1983
3	Mahalanabis et al., "Computer-aided power system analysis" Tata McGraw.	1988
4	Anderson & Fouand "Power system control and stability" Lowa State University Press.	1977
5	"Fundamentals of supervisory systems" IEEE Tutorial Course Text, 91EH0337-6PWR.	1991

Course Name	**:**	**UTILIZATION OF ELECTRICAL ENERGY AND ILLUMINATION ENGINEERING**
Course Code	**:**	**EEN 414**
Credits	**:**	**04**
L T P	**:**	**3-1/2 2/2**

Course Objectives:
At the end of this course, the student should be able toacquire knowledge of different ways of electric energy utilization, understand mechanisms of energy conversion, design illumination systems and maintenance of illumination devices /systems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**ELECTRIC ENERGY AS MECHANICAL POWER** Electric Drives: Advantages of electric drives, Characteristics of different mechanical loads, Types of motors used in electric drive – Textile Drives, Steel rolling mills,D.C. & A.C. traction motors, their characteristics, Traction Motor Control: Starting and speed control of D.C. series motors, shunt transition, bridge transition, drum controller employing shunt transition, energy saving with series parallel starting, multiple unit control, braking of traction motors,Traction Railway electrification – definition and analysis of traction effort – speed – time curve – traction motors - battery driven vehicles - energy efficiency drives – advanced speed control measures- recent trend in electric traction.	11
2	**ELECTRIC ENERGY AS THERMAL ENERGY:** Electric Heating: Advantages of electrical heating, Heating methods: Resistance heating – direct and indirect resistance heating. Induction heating, Electric arc heating, direct and indirect arc heating, Dielectric heating, Infra-red heating, Microwave heating. Electric Welding: Advantages of electric welding, Welding method. Principles of resistance welding, types – spot, projection seam and butt welding. Principle of arc production, electric arc welding, characteristics of arc.	7
3	**ELECTRIC ENERGY AS CHEMICAL ENERGY** Electrolytic Processes: Need of electro-deposition, Laws of electrolysis, process of electro-	7

	deposition, Factors affecting electro-deposition, Principle of galvanizing and its applications. Principles of anodizing and its applications, Electroplating on non-conducting materials, Manufacture of chemicals by electrolytic process and by electrolysis process	
4	**ELECTRIC ENERGY AS LIGHT ENERGY** Introduction: Nature of light, curve of relative sensitivity of human eye, illumination terminology, illumination, Laws of illumination, luminous efficiency, glare, Color, contrast, shadow. Sources: Different type of electric light sources – their operating characteristics. Luminaire required for filament lamp, mercury vapour lamp, fluorescent lamp, metal halide lamp, neon lamp,Compact Fluorescent Lamps, LEDs. General Illumination Design: Calculation of number of light points for interior illumination, depreciation factor, room index and utilization factor, maintenance factor, space to height ratio, reflection factor, calculation of illumination at different points, Selection of equipment, Equipment efficiency. Design of general illumination schemes. Cove lighting and, louver design. General lighting luminaire characteristics etc.Area Lighting**,** Light Control**:** Materials used for light control, Light – beam control, Surface and Media control, Luminaires for light control, Installation of the luminaires, Maintenance and Economics: Maintenance of luminaire, Luminaire depreciation environment, Efficient light production methods, lighting economics.	11
5	**ELECTRIC ENERGY FOR REFRIGERATION & AIR CONDITIONING** Control of temperature - basic wiring diagram - simple heat load and motor calculations. Air-conditioning - function of complete air conditioning system - type of compressor motor and fan motor-wiring diagram for a typical air conditioning unit.	6

List of Experiments:		**Number of Turns**
1	To plot the candlepower, power consumed, current drawn v/s voltage characteristic curve of an Incandescent lamp and compare with the theoretical curves.	1
2	To determine luminous efficiency of a luminaire.	1
3	To determine utilization factor of a luminaire.	1
4	To plot Intensity Polar-Curves of Indoor Luminaire in atleast two planes.	1
5	To plot the candlepower, power consumed, current drawn v/s voltage characteristic curve of a flood lighting luminaire and compare with the theoretical curves	1
6	To calculate Glare index of a luminaire.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Identify and analyze different ways of electric energy utilization.
2	Acquire knowledge of the mechanisms of energy conversion.
3	Analyze and design various illumination systems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	H Partap, "Art and Science of Utilization of Electrical Energy" DhanpatRai& Sons, Delhi	1975
2	W.J.M.VanBommel, "Road Lighting," Kluwer TechnischeBoeken, Macmillan	1980
3	Utilization of Electrical Energy by JB Gupta, Kataria Publications, Ludhiana	1968
4	Open Shaw Taylor, "Utilization of Electrical Energy," Pitman Publications	1962
5	C.L. Wadhwa, "Generation, Distribution and Utilization of Electrical Power," Wiley Eastern Ltd., New Delhi.	2011
6	Prasad M, Refrigeration & Air Conditioning, WileyEastern Ltd., New Delhi.	2007

Course Name	**:**	**ELECTRICAL SYSTEM INSTRUMENTATION AND PROCESS CONTROL**
Course Code	**:**	**EEN415**

Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to have knowledge of various types of control strategies and components used in process control.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**REVIEW OF CONCEPTS OF SYSTEM RESPONSE** Response of first order systems including transfer function and transient response to different forcing functions; Response of first order systems in series including non-interacting and interacting systems.	2
2	**SENSORS AND TRANSDUCERS** Basic concepts and working principles of sensors and transducers for measuring process variables like pressure, temperature, level and flow; electromechanical, capacitive, inductive, resistive and photoelectric type proximity sensors.	8
3	**CONTROLLER PRINCIPLES** Process characteristics; Control system parameters; Discontinuous controller modes; Continuous controller modes; Composite control modes.	5
4	**ANALOG CONTROLLERS** General features; Electronic controllers; Pneumatic controllers; Design considerations.	5
5	**DIGITAL CONTROLLERS** Digital simulation of control systems; Simulation software; Computer software for process control; Microprocessor based controller.	6
6	**CONTROL LOOP CHARACTERISTICS** Control system configuration; Multivariable control system; Control system quality and stability; Process loop tuning.	5
7	**CONTROL EQUIPMENT AND FINAL CONTROL ELEMENTS** Details of controllers including measurement unit, comparator, actuator and final control elements; Pneumatic, hydraulic and electric actuators;Control valve characteristics; Pneumatic to electric and electric to pneumatic converters, hydraulic and pneumatic power supply system.	7
8	**PROGRAMMABLE LOGIC CONTROLLERS** Relay controllers and ladder diagrams; Relay sequences; PLC operation and programming.	4

Course Outcomes: By the end of this course, the student will be able to:	
1	Understand the basic design techniques in Process Control.
2	Understand Different types of controllers used in Process Control.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Coughanowr D. R., "Process Systems Analysis and Control", 2nd Ed., McGraw-Hill International Book Company	2008
2	Johnson C. D., "Process Control Instrumentation Technology", 8thEd., Prentice Hall of India Private Limited	2008
3	Harriott Peter, "Process Control", Tata McGraw-Hill PublishingCompany Limited.	2008
4	Chemsmond C. J., "Basic Control System Technology", Viva Books Private Ltd.	2004
5	Chemsmond C. J., Wilson and Lepla, "Advanced Control System Technology", Viva Books Private Ltd.	2004

Course Name	**:**	**RENEWABLE ENERGY SYSTEMS**
Course Code	**:**	**EEN 416**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
After the end of the course the student should be able to have the knowledge of Non-Conventional Energy Sources, solar and wind energy conversion systems, biomass, tidal and geothermal power plants, operating principle of hydrogen energy, fuel cells and MHD power generation.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Introduction to Energy Sources: Energy sources and their availability, Non-renewable reserves and resources; renewable resources, Transformation of Energy, Environmental effects, Energy conservation.	1
2	**SOLAR ENERGY** (a) Solar processes and spectral composition of solar radiation; Radiation flux at the Earth s surface. Solar collectors. Types and performance characteristics. solar energy storage. (b) Application of solar energy: Solar thermal electric conversion, Thermal electric conversion systems, solar electric power generation, solar photo-Voltaics, solar cell principle, semiconductor junction, conversion efficiency and power output, Basic photovoltaic system for power generation.	2
3	**WIND ENERGY** Wind energy conversion; efficiency limit for wind energy conversion, types of converters, aerodynamics of wind rotors, power ~ speed and torque ~ speed characteristics of wind turbines, wind turbine control systems; conversion to electrical power: induction and synchronous generators, grid connected and self excited induction generator operation, constant voltage and constant frequency generation with power electronic control, single and double output systems, reactive power compensation; Characteristics of wind power plant.	3
4	**TIDAL ENERGY** Wave characteristics, Conversion systems and their performance features application	4
5	**GEOTHERMAL ENERGY** Introduction to Geothermal Energy Conversion	5
6	**BIOMASS ENERGY** Biomass resources, biomass conversion technologies, biogas plants, biomass co-generation, ethanol from biomass.	6

Course Outcomes: By the end of this course, the student will be able to:	
1	have the knowledge of Non-Conventional Energy Sources
2	solar and wind energy conversion systems
3	biomass, tidal and geothermal power plants
4	operating principle of hydrogen energy, fuel cells and MHD power generation

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	G.D.Rai, "Non-Conventional Energy Sources", Khanna Publishers.	2000
2	S.P.Sukhatme, "Solar Energy" Tata McGraw Hill Publishers	1997
3	D.P.Kothari, K.C.Singal, RakeshRanjan, "Renewable Energy Sources and Emerging Technologies" PHI learning Pvt. Ltd. Delhi	2013

Reference Books:	
1	Non-Conventional Sources of Energy by G.D. Rai, Khanna Publishers
2	Renewable energy sources and conversion technology by M.K. Bansal, M.Kleemann, M.Heliss, Tata Mc-Graw-Hill 1990.
3	Bio Energy by David Boyles Elis Horwood Ltd.
4	Direct Energy Conversion by R.A.Coombie, Pitman
5	Learning about Energy by David J.Rose, Plenum Press 1986.
6	Bio Energy Spectrum, Bio Energy and wasteland Development Organization by O.P.Vimal and Tyagi.

Course Name	**:**	**DIGITAL SIGNAL PROCESSING**
Course Code	**:**	**EEN 417**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to acquire knowledge ofdigital signal processing for various process controls, signal and signal processing, time domain representation, transformation, filtered design.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**SIGNAL & SIGNAL PROCESSING** Classification of signals, typical signal processing operations, typical signal processing applications, why digital signal processing	2
2	**TIME DOMAIN REPRESENTATION OF SIGNALS & SYSTEMS** Discrete- time signals, operations on sequences, the sampling process, discrete-time systems, time-domain characters tics of LTI discrete-time systems, state space representation of LTI discrete time systems.	7
3	**TRANSFORMATIONS** Domain representation of signals: the discrete-time Fourier transform, discrete Fourier transform, computation of the DFT of real sequences, linear convolution using the DFT, the z- transform, the inverse z- transform	8
4	**TIME DOMAIN REPRESENTATION OF LTI SYSTEMS** Frequency response, transferfunction. , Digital two-pair stability test.	4
5	**DIGITAL PROCESSING OF CONTINUOUS TIME – SIGNALS** Sampling of continuous time signals, analysis filter design, anti- aliasing filter design, and reconstruction filter design**.**	4
6	**DIGITAL FILTER STRUCTURES** Block diagram representation, signal flow graph representation, equivalent structures, Basic FIR digital filter structures, Basic IIR filters structures, all pass filters, tunable structures**.**	8
7	**DIGITAL FILTER DESIGN** Preliminary conditions, impulse invariance method of IIR filter design, bilinear transform method of IIR filter design, design of filter IIR notch filters, FIR filter design based on truncated Fourier series, FIR filter design based on frequency sampling approach, computer-aided design of digital filters.	9

Course Outcomes: By the end of this course, the student will be able to:	
1	Acquire knowledge of digital signal processing for various process controls.
2	Learn thoroughly signal and signal processing, time domain representation, transformation, filtered design etc. for their projects and research applications.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Digital Signal Processing by Sanjit K. Mitra, Tata McGraw Hill	2001
2	Digital Filters: Analysis & Design by A. Antoniou, McGraw Hill book company	2001
3	Digital Signal Processing by S.D. Sterms, Prentice Hall Inc	1983

Course Name	**:**	**ADVANCED CONTROL SYSTEMS**
Course Code	**:**	**EEN 461**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to acquire knowledge of state variable analysis and design, digital and optimal control, neural network of fuzzy systems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**STATE VARIABLE ANALYSIS AND DESIGN** Introduction, Concepts of State, State Variables and State Model, State Models for Linear Continuous-Time Systems, state variables and linear discrete- time systems, diagonalization, Solution of State Equations, Concepts of Controllability and Observability, Pole Placement by State Feedback, Observer Systems.	13
2	**INTRODUCTION OF DIGITAL CONTROL** Digital control systems: advantages and disadvantages of digital control, representation of sampled process, the z-transform, the z-transfer function. the inverse, -transform and response of linear discrete systems, the z-transform analysis of sampled-data control systems, the z-and s-domain relationship, stability analysis.	12
3	**OPTIMAL CONTROL SYSTEMS** Introduction, parameter optimization: servomechanisms, optimalcontrol problems: state variable approach, the state regulator problem, the infinite-time regulator problem, the output regulator and the tracking problems.	9
4	**NEURAL NETWORKS AND FUZZY SYSTEMS** Introduction to neural networks and fuzzy systems, intelligent control, models of neural networks and fuzzy systems.	8

Course Outcomes: By the end of this course, the student will be able to:	
1	Acquire knowledge of state variable analysis and design.
2	Acquire knowledge of digital and optimal control systems.
3	Acquire knowledge of neural network and fuzzy systems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	M.Gopal, Modern Control System Theory, New Age Intl. Pvt. Ltd.	1993
2	M.Gopal, Digital Control State variable methods, TMH.	2003
3	K. Ogata, Modern Control Engineering, PHI	2010
4	K.Ogata, Discrete Time Control Systems, PHI	1995

Course Name	**:**	**UTILIZATION OF ELECTRICAL ENERGY AND ILLUMINATION ENGINEERING**
Course Code	**:**	**EEN 462**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able toacquire knowledge of different ways of electric energy utilization, understand mechanisms of energy conversion, design illumination systems and maintenance of illumination devices /systems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**ELECTRIC ENERGY AS MECHANICAL POWER** Electric Drives: Advantages of electric drives, Characteristics of different mechanical loads, Types of motors used in electric drive – Textile Drives, Steel rolling mills,D.C. & A.C. traction motors, their characteristics, Traction Motor Control: Starting and speed control of D.C. series motors, shunt transition, bridge transition, drum controller employing shunt transition, energy saving with series parallel starting, multiple unit control, braking of traction motors,Traction Railway electrification – definition and analysis of traction effort – speed – time curve – traction motors - battery driven vehicles - energy efficiency drives – advanced speed control measures- recent trend in electric traction.	11
2	**ELECTRIC ENERGY AS THERMAL ENERGY** Electric Heating: Advantages of electrical heating, Heating methods: Resistance heating – direct and indirect resistance heating. Induction heating, Electric arc heating, direct and indirect arc heating, Dielectric heating, Infra-red heating, Microwave heating. Electric Welding: Advantages of electric welding, Welding method. Principles of resistance welding, types – spot, projection seam and butt welding. Principle of arc production, electric arc welding, characteristics of arc.	7
3	**ELECTRIC ENERGY AS CHEMICAL ENERGY** Electrolytic Processes: Need of electro-deposition, Laws of electrolysis, process of electro-deposition, Factors affecting electro-deposition, Principle of galvanizing and its applications. Principles of anodizing and its applications, Electroplating on non-conducting materials, Manufacture of chemicals by electrolytic process and by electrolysis process	7
4	**ELECTRIC ENERGY AS LIGHT ENERGY** Introduction: Nature of light, curve of relative sensitivity of human eye, illumination terminology, illumination, Laws of illumination, luminous efficiency, glare, Color, contrast, shadow. Sources: Different type of electric light sources – their operating characteristics. Luminaire required for filament lamp, mercury vapour lamp, fluorescent lamp, metal halide lamp, neon lamp,Compact Fluorescent Lamps, LEDs. General Illumination Design: Calculation of number of light points for interior illumination, depreciation factor, room index and utilization factor, maintenance factor, space to height ratio, reflection factor, calculation of illumination at different points, Selection of equipment, Equipment efficiency. Design of general illumination schemes. Cove lighting and, louver design. General lighting luminaire characteristics etc.Area Lighting**,** Light Control**:** Materials used for light control, Light – beam control, Surface and Media control, Luminaires for light control, Installation of the luminaires, Maintenance and Economics: Maintenance of luminaire, Luminaire depreciation environment, Efficient light production methods, lighting economics.	11
5	**ELECTRIC ENERGY FOR REFRIGERATION & AIR CONDITIONING** Control of temperature - basic wiring diagram - simple heat load and motor calculations. Air-conditioning - function of complete air conditioning system - type of compressor motor and fan motor-wiring diagram for a typical air conditioning unit.	6

Course Outcomes: By the end of this course, the student will be able to:	
1	Identify and analyze different ways of electric energy utilization.
2	Acquire knowledge of the mechanisms of energy conversion.
3	Analyze and design various illumination systems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	H Partap, "Art and Science of Utilization of Electrical Energy" DhanpatRai& Sons, Delhi	1975
2	W.J.M.VanBommel, "Road Lighting," Kluwer TechnischeBoeken, Macmillan	1980
3	Utilization of Electrical Energy by JB Gupta, Kataria Publications, Ludhiana	1968
4	Open Shaw Taylor, "Utilization of Electrical Energy," Pitman Publications	1962
5	C.L. Wadhwa, "Generation, Distribution and Utilization of Electrical Power," Wiley Eastern Ltd., New Delhi.	2011
6	Prasad M, Refrigeration & Air Conditioning, WileyEastern Ltd., New Delhi.	2007

Course Name	**:**	**NEURAL NETWORKS AND FUZZY SYSTEMS**
Course Code	**:**	**EEN 463**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to acquire knowledge of neural networks and fuzzy systems, different structure of neural networks, development and implementation of algorithm, and their applications. Design neural networks and fuzzy systems for different applications.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Biological neuron, Models of Artificial Neural Networks (ANN), Characteristics of Neural Networks, Different types of learning of neural network.	4
2	**FUNDAMENTAL MODELS OF ANN** Mcculloch–Pitts, Hebbian, Perceptron, Delta, Owstrar, Boltzman, Adaline, Madaline: Architecture, Algorithm and Applications.	5
3	**FEED FORWARD NETWORKS** Back propagation, Radial basis function- Architecture, Algorithm and Applications.	4
4	**SELF ORGANIZING FEATURE MAP** Kohonen Self Organizing Maps, Learning Vector Quantization (LVQ), Max. Net, Hamming Net-Architecture, Algorithm and Applications.	4
5	**FEEDBACK NETWORKS** Hopfield Net- Architecture, Training Algorithm and Application for discrete and continuous net.	3
6	**ASSOCIATIVE MEMORY NETWORKS** Hetero, Auto and Bi-directional Associative Networks-Architecture, Algorithm and Applications.	3
7	**APPLICATION OF NEURAL NETWORKS** Application of neural network in engineering areas.	3
8	**INTRODUCTION OF FUZZY SYSTEMS** Fuzzy logic, classical sets and fuzzy sets, operations on fuzzy sets, properties of fuzzy sets, crisp and fuzzy relations, membership functions, fuzzification, defuzzification.	9

9	**FUZZY RULE BASED SYSTEM** Formation of rules, decomposition of rules, aggregation and properties of fuzzy rules, fuzzy inference system.	4
10	**APPLICATIONS OF FUZZY LOGIC** Fuzzy logic applications in various areas including power systems, image processing, control systems, industries etc.	3

Course Outcomes: By the end of this course, the student will be able to:	
1	Apply the concepts and rule based fuzzy logic system, design and implementation of fuzzy logic controllers in engineering areas.
2	Have knowledge of concepts, different structure design, implementation of algorithm, and applications of neural networks.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Fundamental of Neural Networks-Architectures, Algorithm and Applications by Laurene Fausett, Pearson,.	1993
2	Neural Networks- A comprehensive foundation bySimon Haykin, Macmillan Publishing Company, New York,.	1994
3	Neural Networks-A classroom approach by Satish Kumar, The McGraw-Hill Companies,.	2005
4	Fuzzy Logic with Engineering Applications by Timothy J. Ross Wiley Student Edition,.	2010
5	Introduction to Neural Networks using MATLAB by S.N.Sivanandam, S. Sumati and S.N.Deepa, Tata McGraw Hill,.	2006
6	Introduction to Fuzzy Logic using MATLAB by S.N.Sivanandam, S. Sumati and S.N.Deepa, Springer,.	2007

Course Name	**:**	**EHVAC AND HVDC TRANSMISSION SYSTEM**
Course Code	**:**	**EEN 421**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course the student should be able to identify EHVAC and HVDC transmission concept, static var system, corona interference in EHVAC and HVDC transmission, harmonic filters and power flow analysis in AC and DC systems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**OVERVIEW**: Comparison of EHV AC and DC transmission, description of DC transmission systems, modern trends in AC and DC transmission. Economic Comparison of HVAC and HVDC. Bulk power transmission at extra high voltages. Comparison of transmission system losses of HVAC and HVDC Transmission systems.	6
2	**EHV AC SYSTEMS**: Limitations of extra long AC transmission, Voltage profile and voltage gradient of conductor, Electrostatic field of transmission line, Reactive Power planning and control, EHV cable transmission system.	6
3	**STATIC VAR SYSTEM**: Reactive VAR requirements, Static VAR systems, SVC in power systems, design concepts and analysis for system dynamic performance, voltage support, damping and reactive	5

	support	
4	**HVDC SYSTEM**: Converter configurations and their characteristics, DC link control, converter control characteristics; Monopolar operation, converter with and without overlap, smoothing reactors, transients in DC line, converter faults and protection, HVDC Breakers.	7
5	**CORONA AND INTERFERENCE:** Corona and corona loss due to EHV AC and HVDC, Radio and TV interference due to EHV AC and HVDC systems, methods to reduce noise, radio and TV interference	6
6	**HARMONIC FILTERS**: Generation of harmonics, design of AC filters, DC filters.	6
7	**POWER FLOW ANALYSIS IN AC/DC SYSTEMS**: Component models, solution of DC load flow, per unit system for DC quantities, solution techniques of AC-DC power flow equations, Parallel operation of HVDC/AC systems, Multi terminal systems.	6

Course Outcomes: By the end of this course, the student will be able to:	
1	By the end of this course, the student will be able to implement the concepts of EHVAC and HVDC transmission concept in their studies or research. The student will be able to solve various problems of static var system, corona interference in EHVAC and HVDC transmission, harmonic filters and power flow analysis in AC and DC systems for a given application**.**

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	EHV-AC,HVDC, Transmission & Distribution Engineering, S. S. Rao	2009
2	Padiyar K.R., HVDC Power Transmission Systems, Wiley Eastern Ltd., New Delhi.	2000

Course Name	**:**	**ADVANCED POWER ELECTRONICS**
Course Code	**:**	**EEN 422**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of the course the student should be able to analyze, evaluate and design advanced switching techniques for DC-DC converters, multilevel DC-AC converters,AC-DC converters and multipulse converters for power quality improvement.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**ADVANCED DC-DC CONVERTERS** Non-isolated switch mode dc-dc converters: converter transfer function, buck, boost, buck-boost, fourth order converters, bipolar output voltage converters, effect of converter non idealities, switch utilization factor. Isolated switch mode converters: Transformer circuit configurations, Buck derived isolated converters-single ended forward converter, half & full bridge converter, push pull converter, Boost derived isolated converters. Soft switching dc-dc converters: resonant converters, ZCS and ZVS topologies, generalized analysis of ZCS, zero voltage and zero current transition converters. Voltage and current mode control of PWM converters.	13
2	**ADVANCED DC-AC CONVERTERS** Methods of Harmonic Reduction. Current Source Inverter, Variable DC Link Inverter, Boost Inverter. Introduction to Inverter Circuit Design. Multilevel Inverters: Introduction and Basic	16

	Concept, Types of Multilevel Inverters (Diode Clamp, Flying Capacitor, Cascaded), Switching Device Currents, DC- Link Capacitor Voltage Balancing. Features of Multilevel Converters. Applications of Multilevel Inverters: Reactive Power Compensation, Back to Back Intertying and Adjustable Speed Drives. Resonant Pulse Inverters: Introduction, Series and Parallel Resonant Inverters, ZVS and ZCS Resonant Converters.	
3	**ADVANCED AC- DC CONVERTERS** Line Commutated Rectifiers: 1ø and 3ø half and fully controlled rectifier configurations with R, L, RL and RLE load. Continuous and Discontinuous Conduction Mode. Definitions of Fundamental Real Power (P) and Reactive Power (Q) of converters and associated VAR Diagrams. Effect of Source Inductance on output voltage. Phase Control of output voltage and inverter mode (Line Commutated Inverter). Necessary Precautions in the inverter mode. Multi-pulse methods for harmonics reduction: Introduction to multi pulse methods for reduction of harmonics: Principle of cancellation of harmonics, determination of phase shift and vector representation. Analysis of 12 pulse converter (Wye-Wye and Wye-Delta) configuration for 30 degree phase shift. Introduction to PWM rectifiers: Power factor Corrected rectifiers.	13

Course Outcomes: By the end of this course, the student will be able to:	
1	Analyze, evaluate and design advanced switching techniques for DC-DC converters.
2	Analyze advanced switching strategies of DC-AC converters and analyze multilevel DC-AC converters.
3	Analyze advancedAC-DC converters and multi-pulse converters for power quality improvement.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	B.R.Pelly, "Thyristor Phase Controlled Converters and Cycloconverters", John Wiley and sons, ISBN 0-471-67790-6.	1971
2	L Gyugyi and B.R.Pelly, "Static Power Frequency Changers", John Wiley and Sons, ISBN 0-471-67800-7.	1976
3	Guy Seguier, Christian Rombaut and Robert Bausiere "Power electronic Converters: Volume 2 AC-AC Conversion", North Oxford Academic Publishers, ISBN 0-07-053630-9.h	1987
4	R.S.Ramshaw, "Power Electronic Semiconductor switches", Chapman and Hall, ISBN 0-412-28870-2.	1994
5	R.W.Erickson and DraganMaksimovic, "Fundamentals of Power Electronics", KLUWER Academic Publishers, ISBN 0-7923-7270-0.	2004
6	M H Rashid, "Power Electronics: Circuits, Devices and Applications", 3rd Edition, Prentice Hall of India Pvt Ltd, ISBN 81-203-2503-6	2004
7	N Mohan, T.M. Undeland and W.P.Robbins, "Power Electronics: Converters applications and design", John Wiley and sons, ISBN 81-265-1090-0.	2006
8	Marian K Kazimierczuk, "Pulse-width Modulated DC–DC Power Converters", John Wiley and Sons, ISBN: 978-0-470-77301-7.	2008

Course Name	**:**	**FAST TRANSIENTS IN POWER SYSTEMS**
Course Code	**:**	**EEN 423**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:

At the end of this course the student should be able to describe the concepts, origin and the effect of fast transients, lightning phenomenon, theory of ground wires, switching surges, insulation coordination, transients in integrated power systems and computer aided calculation of electrical transients.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**INTRODUCTION TO FAST TRANSIENTS**: Origin and nature of power system Transients, traveling waves on transmission system, the line equation, the shape attenuation and distortion of waves, reflection of traveling waves , successive reflections, traveling waves on multi conductor systems, transition points on multi conductor circuits.	6
2	**LIGHTNING:** Charge formation, mechanism of lightning stroke. Mathematical model of lightning stroke.	5
3	**THEORY OF GROUNDS WIRES:** Direct stoke to a tower, effect of reflection up and down the tower , the counterpoise.	5
4	**SWITCHING SURGES**: Normal frequency effects, high charging currents, cancellation waves, recovery voltage, restricting phenomena. Protection of transmission systems against surge.	7
5	**INSULATION COORDINATION**: Insulation coordination procedures (IEC) for high voltage systems: Design criteria, classification of over voltages, insulation design for switching, lightning and temporary over voltages, pollution, application of arresters for protection of lines and stations, statistical methods of insulation coordination, risk of failure, test prescriptions. Insulation coordination procedures (IEC) for low voltage systems: representative over voltages, selection of clearance and creep age distances, macro and micro environments, testing techniques.	10
6	**TRANSIENTS IN INTEGRATED POWER SYSTEMS:** Introduction, the short line or kilometric fault, line dropping and load rejection, voltage transients on closing and re-closing lines, over voltages induced by faults, switching high-voltage direct current lines, switching surges on an integrated system, transients in the industrial power network, transients due to capacitor switching.	5
7	**COMPUTER AIDED CALCULATION OF ELECTRICAL TRANSIENTS:** Introduction, pre-calculated curves for computing switching transient recovery voltages, the transient network analyzer, computer aided treatment of transients	4

Course Outcomes:	
1	By the end of this course, the students will be able to apply the concepts, origin and the effect of fast transients, lightning phenomenon, theory of ground wires, switching surges, insulation coordination and transients in integrated power systems and computer aided calculation of electrical transients.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Allan Greenwood , Electrical Transients in power Systems , Wiley Iterscience	2002
2	L.V Bewley, Travelling waves on transmission system, power publications Inc. New York	1963
3	R Rudenterg, Electric Stroke waves in power systems, Harvard University press, Cambridge, Massachusetts	1968
4	Transmission Line Reference Book, EPRI, USA	1982
5	Gonen, T., "Electric Power Transmission System Engineering: Analysis and Design", Wiley	1988

Course Name	**:**	**ADVANCED DESIGN TECHNIQUES IN CONTROL SYSTEMS**
Course Code	**:**	**EEN 424**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of the course the student should be able to develop model for simple engineering systems in the frame work pf optimal and robust control, and design the optimal and robust controllers, have knowledge of fuzzy logic systems and apply the fuzzy logic control to simple engineering problems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Multivariable systems, design requirements of feedback control systems, limitations of classical control methods, modern versus classical control methods	3
2	**PERFORMANCE AND UNCERTAINTY REPRESENTATION FOR MIMO SYSTEMS** Operator norms , Singular Values, use of singular values for assessing performance, open & closed loop requirements, , representation of uncertainty, stability robustness & performance robustness	5
3	**OPTIMAL CONTROL DESIGN** Performance indices, optimal control, linear quadratic regulators, performance and robustness of optimal state feedback , tracking control,	5
4	**LQG/LTR** LQG problem and design methods, , Loop Transfer Recovery (LTR), design, design procedure for square plant, shaping of singular values.	5
5	**H∞ BASED ROBUST CONTROL METHODS** H∞ problem formulation, Youla (or Q) parameterization, fractional representations, parameterization of all stabilizing controllers, parameterization of closed loop transfer functions. Equivalence to model matching problem and Hankel approximation problem, 1-block, 2-block and 4-block problems, solution of H∞ control problem	8
6	**FUZZY LOGIC SYSTEMS** fuzzy versus crisp, introduction to fuzzy sets, operations & relations on crisp and fuzzy sets, crisp logic, predicate logic, fuzzy logic, fuzzy rule based systems, fuzzification, knowledge base, decision making, defuzzification,	8
7	**FUZZY LOGIC CONTROL AND APPLICATIONS** Fuzzy logic control &architectures of fuzzy logic control systems., engineering applications of fuzzy logic control	8

Course Outcomes: By the end of this course, the student will be able to:	
1	Develop model for simple engineering systems in the frame work pf optimal and robust control, and design the optimal and robust controllers.
2	Understand the fuzzy logic systems and apply the fuzzy logic control to simple engineering problems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Modern Control System Theory ,M. Gopal, New Age International Publishers	1993
2	Multivariable Feedback Design, J.M.Maciejowski, Addison-Wesley Publishing Company.	2006
3	Neural Networks, Fuzzy Logic and General Algorithms,,S.Rajasekharan and G.A. Vijayalakshmi Pai, PHI	2011
4	Fuzzy logic with Engineering Applications, Timothy J.. Ross, Fuzzy logic with Engineering Applications, Wiley Student Edition	1995
5	Multivariable Feedback Control, S. Skogestad and I. Postlethwaite, Wiley	1998

Course Name	**:**	**STATIC REACTIVE POWER CONTROL AND FACTS**
Course Code	**:**	**EEN 425**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of the course the student should be able to : Have knowledge of the basic concepts of reactive power transmission, FACTS, voltage source converters, self and line commutated current sourced converters, UPFC, TCBR, Sen Transformer etc.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Principles of reactive power control in load and transmission line compensation, series and shunt reactive power compensation. Concepts of Flexible AC Transmission System (FACTS).	6
2	Power Semiconductor Devices, Voltage-sourced converters, Self and line-Commutated Current-Sourced Converters.	8
3	Static shunt compensators, Static series compensators, Static Voltage and phase angle regulators, Unified Power Flow Controller and interline Power Flow Controller.	20
4	Special topics: TCBR, Sen Transformer, Harmonics and filters	8

Course Outcomes: By the end of this course, the student will be able to:	
1	Have knowledge of concepts of reactive power transmission, FACTS, voltage source converters, self and line commutated current sourced converters, UPFC, TCBR, Sen Transformer in electrical power system for a given application.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	N.G. Hingorani and L.Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, Standard Publishers-Distributors.	1999
2	R.K.Varma and R.M.Mathur, "Thyristor Controlled Flexible AC Transmission System" IEEE Press.	1999

Course Name	**:**	**ELECTRICAL MACHINES**
Course Code	**:**	**EEN 431**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course the student should be able to 1. Have knowledge of constructional features, principle of operation of various types of transformers and DC machines. 2. Analyze magnetic circuits in different types of electromechanical energy conversion systems. 3. Evaluate the performance of transformers, DC machines, synchronous machine and induction machine.

Total No. of Lectures – 42

Lecture wise breakup	**Number of Lectures**

1	**MAGNETIC CIRCUITS** Magnetic Circuit properties, Magnetic materials, magnetic circuit calculation, transformer magnetic circuit, machine magnetic circuit, total flux, leakage flux effects in transformers and machine, effect of saturation.	4
2	**SINGLE PHASE STATIC TRANSFORMERS** Introduction to transformers types, core, winding, insulation, induced voltage, transformer on open circuit, ideal transformer, dot convention, equivalent circuit of practical transformer, regulation and efficiency from approximate equivalent circuit. Losses in a transformer: calculation of eddy current and hysteresis losses, open circuit and short circuit tests. Parallel operation of single phase transformers. Autotransformer.	7
3	**DC MACHINES** Generalized singly and doubly excited electromechanical conversion system. DC machines principles and construction: generator action, motor action, commutator, commutation action using split ring, pole cores, shunt and series winding, interpolar and compensating windings, brushes, armature core. Armature windings types, armature reaction. DC generator: back torque, magnetization characteristics, effect of speed upon voltage, leakage flux, separately and self excited generators, voltage buildup, external characteristics of series, shunt and compound generators, voltage regulation. DC motor: back emf, variation of back emf, torque, power developed, armature current with speed for shunt series and compound motors, effect of saturation, speed regulation, starters, speed control of DC motors, braking of DC motors.	9
4	**THREE PHASE INDUCTION MACHINES** General construction features, rotating field theory, per phase equivalent circuit, approximate equivalent circuit, production of torque, slip, torque speed characteristics, max power and max torque criterion, maximum efficiency criterion, no load and blocked rotor test to determine performance parameters. Starting: rotor rheostat starter, reduced voltage starting, star delta starting. Deep bar and double cage rotor. Speed control: pole changing, line voltage control, line frequency control, rotor resistance control, injection of emf in the rotor circuit. Introduction to Braking.Introduction to Single Phase Induction Motor.	11
5	**SYNCHRONOUS MACHINE** Construction features, armature windings, winding connections, induced emf equation, equivalent circuit, synchronous and leakage reactance, cylindrical rotor machine performance with constant synchronous reactance, armature reaction, vector diagram, generator external characteristics and voltage regulation, Efficiency, losses in synchronous generator, parallel operation of synchronous generators. operation of synchronous motor, V curves and inverted V Curves, effects of armature reaction, vector diagrams, effect of change in load and field excitation, electromagnetic power in salient and cylindrical rotor motor, hunting, damping, methods of starting of synchronous motor.	11

Course Outcomes: By the end of this course, the student will be able to:	
1	Analyze and evaluate magnetic circuits.
2	Analyze and evaluate the performance of transformers, DC machines, synchronous machine and induction machine

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Alternating Current Machines by M.G Say, Pitman publishing Ltd, ISBN 0-273 36197-X	1976
2	Electric Machinery by A.E. Fitzgerald, Charles Kingsley, Jr. and Stephen D. Umans, Tata McGraw-Hill, ISBN 0-07-366009-4.	2013
3	The Performance and Design of Direct Current Machines by Albert E Clayton & N N Hancock, CBS publishers and distributors.	1974
4	Alternating Current Machines by Thomas C McFarland, D Van Nostrand Company.	1948

5	Principles of Alternating Current Machinery by Ralph R Lawrence, McGraw- Hill book company.	1921
6	Direct Current Machinery by Charles S Siskind, McGraw- Hill book company.	1952
7	Electric Machinery and Transformers by Bhag S Guru & Huseyin R Hiziroglu, Oxford University Press, ISBN 0195138902.	2000
8	Principles of Electric Machines And Power Electronics by P C Sen, Wiley India, ISBN 81-265-1101-X	2013
9	Electric Machines by D P Kothari and I J Nagrath, Tata Mcgraw Hill Education Private Limited, ISBN 0070699674	2004

Course Name	**:**	**POWER GENERATION, TRANSMISSION AND UTILIZATION**
Course Code	**:**	**EEN 432**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able toacquire knowledge of generation, transmission, distribution and utilization of electrical energy.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**ELECTRIC POWER GENERATION** Conventional and non-conventional sources of energy, thermal, hydroelectric, diesel, nuclear power plants, solar, wind geothermal, tidal, MHD power Generation. Power Plant economics, load factor, demand factor, diversity factor, plant factor, tariff, depreciation. Power factor, importance and improvement techniquesof power factor.	10
2	**ELECTRIC POWER TRANSMISSION** Overhead and underground power transmission systems, arrangement of conductors, transmission line supports and their location, economic span, choice of transmission voltage, line insulation types, string efficiency, impulse ratio, arcing horns and rings, failure of insulation. Phenomena of corona, disruptive critical voltage, advantages and disadvantages of corona. Calculation of transmission line inductance and capacitance, GMD and GMR, bundled conductors, transposition, representation of short, medium and long lines, ABCD constants, Performance analysis of transmission lines using nominal T and π methods.	10
3	**ELECTRIC POWER DISTRIBUTION** Classification and arrangement of distribution systems, voltage dropcalculations in radial and ring mains, comparison of different AC/DC distribution systems.Underground cables, different types, insulation resistance, capacitance of single core cables,grading of cables, capacitance of three core cables, sheath effects.	8
4	**UTILIZATION OF ELECTRICAL ENERGY** Introduction to Illumination, Nature of light, curve of relative sensitivity of human eye, illumination terminology, illumination, Laws of illumination, luminous efficiency, glare, Color, contrast, shadow. Different type of electric light sources – their operating characteristics. Luminaire required for filament lamp, mercury vapour lamp, fluorescent lamp, metal halide lamp, neon lamp,Compact Fluorescent Lamps, LEDs. General ideas bout street lighting, flood lighting, tunnel lighting, monument lighting and decorative lighting, area lighting luminaire characteristics etc. Introduction to Electric Heating, advantages of electrical heating, Heating methods: Resistance heating – direct and indirect resistance heating. Induction heating, Electric arc heating, direct and indirect arc heating, Dielectric heating, Infra-red heating, Microwave heating. Electric Welding: Advantages of electric welding, Welding method. Principles of resistance welding, types – spot, projection seam and butt welding. Principle of arc production, electric arc welding, characteristics of arc.	14

Course Outcomes: By the end of this course, the student will be able to:	
1	Acquire knowledge of electrical generation, transmission and distribution.
2	Identify and analyze different ways of electric energy utilization.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	H Partap, "Art and Science of Utilization of Electrical Energy" DhanpatRai& Sons, Delhi	1975
2	W.J.M.VanBommel, "Road Lighting," Kluwer TechnischeBoeken, Macmillan	1980
3	Utilization of Electrical Energy by JB Gupta, Kataria Publications, Ludhiana	1968
4	Open Shaw Taylor, "Utilization of Electrical Energy," Pitman Publications	1962
5	C.L. Wadhwa, "Generation, Distribution and Utilization of Electrical Power," Wiley Eastern Ltd., New Delhi.	2011

Course Name	**:**	**RENEWABLE ENERGY SYSTEMS**
Course Code	**:**	**EEN 416**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to describe the renewable energy systems such as solar energy, wind energy, direct energy conversion, energy from biomass, hydro energy (micro/mini hydro plants).

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Introduction to Energy Sources: Energy sources and their availability, Non-renewable reserves and resources; renewable resources, Transformation of Energy, Environmental effects, Energy conservation.	4
2	**SOLAR ENERGY** (c) Solar processes and spectral composition of solar radiation; Radiation flux at the Earth s surface. Solar collectors. Types and performance characteristics. solar energy storage. (d) Application of solar energy: Solar thermal electric conversion, Thermal electric conversion systems, solar electric power generation, solar photo-Voltaics, solar cell principle, semiconductor junction, conversion efficiency and power output, Basic photovoltaic system for power generation.	8
3	**WIND ENERGY** Wind energy conversion; efficiency limit for wind energy conversion, types of converters, aerodynamics of wind rotors, power ~ speed and torque ~ speed characteristics of wind turbines, wind turbine control systems; conversion to electrical power: induction and synchronous generators, grid connected and self excited induction generator operation, constant voltage and constant frequency generation with power electronic control, single and double output systems, reactive power compensation; Characteristics of wind power plant.	7
4	**TIDAL ENERGY** Wave characteristics, Conversion systems and their performance features application	3
5	**GEOTHERMAL ENERGY** Introduction to Geothermal Energy Conversion	3

6	**BIOMASS ENERGY** Biomass resources, biomass conversion technologies, biogas plants, biomass co-generation, ethanol from biomass.	6
7	**HYDRO ENERGY** Electricity generation and Water pumping, Micro/Mini hydropower systems, Water pumping and conversion to electricity	6
8	**HYDROGEN, FUEL CELL** Hydrogen, generation, storage, transport and utilization and transport. Fuel cell technology – Types, power generation and economics.	5

Course Outcomes:	
1	By the end of this course, the student will be able to design and analyze renewable energy systems such as solar energy, wind energy, direct energy conversion energy from biomass, hydro energy systems (micro/mini hydro plants)for future research work or studies.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	D. P. Kothari, K. C. Singal, R. Ranjan, Renewable Energy Sources and Emerging Technologies, Prentice Hall of India, New Delhi	2008
2	S. N. Bhadra, D. Kastha, S. Banerjee, Wind Electrical Systems, Oxford Univ. Press, New Delhi	2005
3	S. A. Abbasi, N. Abbasi, Renewable Energy Sources and Their Environmental Impact on Global Warming & Pollution, PHI	2011

Course Name	**:**	**POWER ELECTRONICS**
Course Code	**:**	**EEN 434**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:
By the end of this course, the students should be able to: Have knowledge of various power electronic devices, switching transients and snubber circuits and analyze various types of AC-DC, DC-DC, DC-AC, AC-AC conversion using power electronic converters.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**POWER ELECTRONIC DEVICES** Introduction to power switching devices, basic structure and physics of device operation, switching and I-V characteristics (diodes, thyristors, GTO, BJT, Power MOSFET, IGBT). Series and parallel operation of thyristors.	5
2	**PRACTICAL CONVERTER DESIGN CONSIDERATIONS** Snubber Circuits: Function and type of snubber circuits, Turn off, turn on and Overvoltage Snubbers. Gate and Base Drive Circuits: Trigger techniques, optical isolators, protection circuits, isolation transformers.	3
3	**AC- DC CONVERSION CIRCUITS** Introduction to Power Processing, Principles of Steady State Converter Analysis: Inductor volt-second balance, Capacitor Charge Balance and Small Ripple Approximation. Line Commutated Rectifiers: Natural Commutation of SCRS, 1ø and 3ø half and fully controlled rectifier configurations with R, L, RL and RLE load. Continuous and Discontinuous Conduction Mode.	8

4	**CHOPPER CIRCUITS** Types of chopper: step up, step down. Different classes of chopper circuits: Class A, B, C, D, E. for R, R-L and RLE load. Types of commutation circuits.	4
5	**DC-DC SWITCH MODE CONVERTERS** Introduction to DC-DC Converters, Control of DC-DC Converters, Buck Converter, Boost Converter, Buck-Boost Converter, Cuk Converter, Full Bridge DC-DC Converter	7
6	**AC VOLTAGE CONTROLLERS** Basic Principle, Analysis of 1Ø operation with R and RL Load, Load and Supply Current Characteristics. 3Ø Fully and Half controlled Regulator: Analysis of operation for R and RL Load (various modes of operation).	4
7	**DC-AC CONVERSION** 1- Ø and 3- Ø bridge inverters, Voltage Control of Three Phase Inverters: Sinusoidal PWM, 60 Degree PWM, Third Harmonic PWM .Comparison of Various PWM Techniques.	7
8	**CYCLOCONVERTORS** Basic Operational features and Operating Principles. Mathematical Representation (output voltage and Input Current) of Static Frequency Changers. Synthesis of the Output Voltage Waveform.	4

Course Outcomes: By the end of this course, the student will be able to:	
1	Analyze various power electronic devices, switching transients and snubber circuits.
2	Analyze and evaluate various types of AC-DC, DC-DC, DC-AC, AC-AC conversion using power electronic converters.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Guy Seguier, Christian Rombaut and Robert Bausiere "Power electronic Converters: Volume 2 AC-AC Conversion", North Oxford Academic Publishers	1987
2	B.R.Pelly, "Thyristor Phase Controlled Converters and Cycloconverters", John Wiley and sons	1971
3	L Gyugyi and B.R.Pelly, "Static Power Frequency Changers", John Wiley and Sons,	1976
4	Doebeling, E.O.,: Measurement Systems- Application and Design, McGraw Hill Publishing Company	1990
5	R.S.Ramshaw, "Power Electronic Semiconductor switches", Chapman and Hall,	1994
6	R.W.Erickson and DraganMaksimovic, "Fundamentals of Power Electronics", KLUWER Academic Publishers,	2004
7	M H Rashid, "Power Electronics: Circuits, Devices and Applications", 3rd Edition, Prentice Hall of India Pvt Ltd,	2004
8	N Mohan, T.M. Undeland and W.P.Robbins, "Power Electronics: Converters applications and design", John Wiley and sons	2006
9	Marian K Kazimierczuk, "Pulse-width Modulated DC–DC Power Converters", John Wiley and Sons	2008

Course Name	**:**	**ELECTRICAL MEASUREMENT AND INSTRUMENTATION**
Course Code	**:**	**EEN 435**
Credits	**:**	**04**
L T P	**:**	**3- 1-0**

Course Objectives:

To be able to knowledge of principles of measurement of electrical quantities, construction and operating principles of electrical instruments, their static and dynamic characteristics, and errors in measurement and apply knowledge of measuring instruments to other areas of electrical engineering.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Functional elements of an instrument, static and dynamic characteristics, errors in measurement, statistical evaluation of measurement data, standard and calibration. Measurement of Error, Accuracy and Precision, significant figures, types of error, Statistical analysis of data, probability of errors, limiting errors.	6
2	**ANALOG INSTRUMENTS** Electromechanical instruments – moving, coil, moving iron, electrostatic instruments, current, voltage and power measurements, induction type energy meter, frequency meter, power factor meter, megger, magnetic measurements, instrument transformers.	10
3	**SENSORS AS TRANSDUCERS** Classification of Transducers, selection of transducers: resistive, capacitive and inductive transducers, piezo electric Transducers, optical and digital transducers, transducers for measurement of displacement, temperature, level, flows, pressure, velocity and acceleration.	8
4	**BRIDGE MEASUREMENTS** Wheatstone Bridge, Kelvin Bridge, a.c. bridge and their application for the measurement of self-inductance and mutual inductance, Wagner Ground connection, measurement of capacitance, Measurement of low and high resistance.	7
5	**ANALOG ELECTRONIC INSTRUMENTATION** Analog electronic voltmeters, tuned and sampling voltmeters, Analog electronic wattmeter and energy meter.	3
6	**SIGNAL GENERATORS AND ANALYSERS** Introduction to signal generators, characteristics of signal generators, multi-vibrators, CRO, harmonic distortion and spectrum analyzer.	3
7	**DIGITAL ELECTRONIC MEASUREMENT** Digital counter-timer and frequency meter, time standards, digital voltmeter and multimeter, accuracy and resolution considerations, comparison with analog electronic instruments.	5

Course Outcomes: By the end of this course, the student will be able to:	
1	Knowledge of principles of measurement of electrical quantities, construction and operating principles of electrical instruments, their static and dynamic characteristics, and errors in measurement.
2	Design and conduct experiments, as well as to analyze and interpret data.
3	Apply knowledge of measuring instruments to other areas of electrical engineering.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Doebeling, E.O., Measurement Systems – Application and Design, McGraw Hill Publishing Compnay.	1990
2	Mooris. A.S., Principle of Measurement and Instrumentation, Prentice Hall of India	1999
3	Dalley, J.W., Riley, W.F. and Meconnel, K.G., Instrumentation for Engineering Measurement, John Wiley & Sons	1999
4	A.K.Sawhney, A course in Electrical and Electronics Measurements and Instruments, Dhanpat Rai & Co. (Pvt.) Ltd.	2000

GENERAL SCIENCE COURSES (GSC)

Course Name	**:**	**ENVIRONMENTAL SCIENCES**
Course Code	**:**	**GSC101**
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:
This course aims to acquaint students with the basics of Environmental Sciences.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Multi-discipline nature of environmental studies as applied to different engineering streams - Definitions, scopes and explanations.	6
2	Types of Ecosystems – System dynamics – Understanding ecosystems, Ecosystem degradation, Resource utilization, Ecosystem diversity, Habitat classification.	6
3	Natural Resources; Renewable and non-renewable- Natural resources and associated problems, Non-renewable resources, Renewable resources	6
4	Energy and Environment- Fossil fuel, Geothermal, tidal, nuclear, solar, wind, hydropower & biomass.	6
5	Environment pollution- Air Pollution, Water Pollution, Soil Pollution, Marine Pollution, Noise Pollution, Thermal Pollution, Nuclear hazards	6
6	Cleaner Production and life cycle analysis: - LCA methodology, steps and tools, EIA and Environment audit	6
7	Environment Development and Society:- Emerging technology for sustainable development and environment management, public participation and provision in management and legislation.	6

Course Outcomes:	
1	Students will be able to relate the importance of Environmental Sciences for sustainable development of society.
2	Students will be able to understand the problems and remedies of Environmental Sciences.

Text Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	Environmental Science Ceonage Learning Publication, Miller G.T. and Spool Mar
2	Environmental Studies, Tata McGraw Hill Pub., Banny Joseph

BASIC SCIENCE COURSES (BSC)

Course Name	**:**	**MATHEMATICS I**
Course Code	**:**	**MAN 101**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:

To make the students understand the behavior of infinite series and their use.
To make the students learn the concepts related to functions of several variables and their applications.
To make the students learn the methods of evaluating multiple integrals and their applications to various problems.
To make the students learn the methods to formulate and solve linear differential equations and apply them to solve engineering problems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INFINITE SERIES** Infinite series and convergence, alternating series, power series and convergence. Taylor's and Maclaurin's Series. (Scope as in Chapter 8, Sections 8.1, 8.3 – 8.9 of Reference Book 1).	8
2	**MULTIVARIABLE FUNCTIONS** Limit, Continuity and Partial Derivatives; Euler's Theoem for Homogeneous functions; Differentiability, Linearization and Differentials; Chain rule; Extreme values and Saddle Points; Lagrange multipliers; Taylor's Formula**.** (Scope as in Chapter 12, Sections 12.1 – 12.6, 12.8 – 12.10 of Reference Book 1).	10
3	**SOLID GEOMETRY** Cylinders and Quadric surfaces, Cylindrical and Spherical Coordinates. (Scope as in Chapter10, Sections10.6 and 10.7 of Reference Book 1)	4
4	**INTEGRAL CALCULUS** Area between plane curves; Volumes of solids of revolution; Lengths of plane curves; Areas of surfaces of revolution. Double integrals in rectangular and Polar form, Triple integrals in Rectangular, Cylindrical and Spherical coordinates, Substitutions in Multiple Integrals. (Scope as in Chapter 5, Sections 5.1, 5.3, 5.5, 5.6 and Chapter 13 .Sections 13.1, 13.3, 13.4,13.6 and 13.7 of Reference Book 1).	8
5	**ORDINARY DIFFERENTIAL EQUATIONS** First order exact differential equations, Integrating factor, Orthogonal trajectories, Second and Higher order Linear Differential Equations with constant coefficients, Differential Operators, Methods of Variation of Parameters and Undetermined Coefficients, Euler Cauchy Equation, Wronskian. (Scope as in Chapter 1, Section 1.5, 1.8 Chapter 2, 2.1-2.4, 2.6, 2.9-2.10, 2.13- 2.15 of Reference Book 2).	12

Course Outcomes:	
1	The students are able to test the behavior of infinite series.
2	The students are able to analyze functions of several variables and their applications.
3	The students are able to evaluate multiple integrals and apply them to practical problems.
4	The students are able to solve linear differential equations.

Reference Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	G. B. Thomas, R. L. Finney. Calculus and Analytic Geometry, Ninth Edition, Pearson Education.

2	E. Kreyszig. Advanced Engineering Mathematics, Eighth Edition, John Wiley.
3	B. V. Ramana. Higher Engineering Mathematics, Tata McGraw Hill.

Course Name	**:**	**PROBABILITY AND STATISTICS**
Course Code	**:**	**MAN 103**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to use statistical methods to collect and analyze the data. The students should be able to estimate unknown parameters of populations and apply the tests of hypotheses.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS** Random variables, Discrete, Continuous and Joint Probability distributions, Marginal and Conditional distributions, Independent random variables, Expectation, Variance and Covariance, Means and variances of linear combinations of random variables, Chebyshev's inequality, Binomial, Poisson, Uniform and Normal distributions, Normal and Poisson approximations to Binomial, Moments, Moment generating function.	20
2	**SAMPLING DISTRIBUTIONS & ESTIMATION** Population, Sample, Sampling distributions, Law of large numbers, Central limit theorem, Distribution of sample mean, Difference of means, Proportions and difference of proportions, Chi-square distribution, Student's t-distribution, Estimation of parameters, Point estimate, Confidence interval for mean, difference of means and proportions.	16
3	**TESTS OF HYPOTHESES** Hypothesis, Test statistic, Critical region, Significance level, Single Sample and Two Samples tests for mean.	6

Course Outcomes: By the end of this course, the student will be able to:	
1	Collect and analyze the data statistically.
2	Describe sampling distributions of sample means and sample proportions
3	Estimate unknown parameters of the population from a sample.
4	Construct confidence intervals for mean difference of means and proportions; and perform hypothesis tests for means.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Probability and statistics for Engineers and Scientists, Walpole, Myers, Myers and Ye, Pearson Education	2012
2	Introduction to Mathematical Statistics, Hogg and Craig, Pearson Education	2013
3	Miller and Freund's: Probability and Statistics for Engineers, Richard A. Johnson, Prentice	2010

	Hall	
4	John E. Freund's: Mathematical statistics with Application, Miller and Miller, Pearson Education	2012

Course Name	**:**	**VECTOR CALCULUS, FOURIER SERIES AND LAPLACE TRANSFORM**
Course Code	**:**	**MAN105**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:

At the end of this course, the students should be able to use concepts of vector calculus to analyze scalar and vector fields and compute the gradient, divergence and curl. They should be able to evaluate line, surface and volume integrals. The students should be able to expand functions in a Fourier series and apply Harmonic analysis to numerical data. They should be able to evaluate Laplace transforms and inverse Laplace transform and apply Laplace transforms to solve ordinary differential equations.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**VECTOR CALCULUS** Gradient, Divergence and Curl – their physical interpretation and representation in cylindrical and spherical coordinates. Line, surface and volume integrals; Green's theorem in the plane, Stoke's theorem, Divergence theorem; Irrotational and Solenoidal Fields, Applications to Science and Engineering.	20
2	**FOURIER SERIES** Periodic functions, Trigonometric series, Fourier Series, Euler's formulae, Conditions for existence of Fourier series, Even and odd functions, Half range expansions, Complex Fourier series, Applications of Fourier series, Parseval's identity, Harmonic analysis.	12
3	**LAPLACE TRANSFORM** Laplace transform, Inverse transform, properties, Transforms of derivatives and integrals, Unit step function, Dirac's delta function, Differentiation and integration of transforms, Applications to differential equations.	10

Course Outcomes:	
1	Use vector calculus to analyze scalar and vector fields and compute the gradient, divergence and curl.
2	Evaluate line, surface and volume integrals.
3	Apply Green's Theorem, Divergence Theorem and Stoke's theorem to evaluate integrals..
4	Expand a function in terms of its Fourier series and to apply harmonic analysis to numerical data.
5	Evaluate Laplace transforms and inverse Laplace transforms of functions.
6	Apply Laplace transforms to solve ordinary differential equations arising in engineering problems.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Calculus and Analytic Geometry, G. B. Thomas and R. L. Finney, Pearson Education	2014
2	Advanced Engineering Mathematics, E. Kreyszig, John Wiley	2006

3	Advanced Engineering Mathematics, M.D. Greenberg, Pearson Education Asia	2010
4	Advanced Engineering Mathematics, Wylie and Barrett, McGraw Hill	2003

Course Name	**:**	**PARTIAL DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS**
Course Code	**:**	**MAN 106**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to formulate and solve linear and nonlinear partial differential equations and apply partial differential equations to engineering problems. The students should be able to solve ordinary differential equations using series solutions, describe special functions as solutions to differential equations and expand functions in terms of eigenfunctions and to solve Sturm Liouville's problems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**PARTIAL DIFFERENTIAL EQUATIONS** Formation and solution of first order partial differential equations, Linear equations of higher order with constant coefficients, Applications to Engineering problems**.**	17
2	**SPECIAL FUNCTIONS** Series solution of differential equations, Power series methods, Series solution of Legendre's differential equation Legendre's polynomial, generating functions, Recurrence relations, Frobenius method, Series solution of Bessel's differential equation, Bessel's functions, Modified Bessel's functions, generating functions, Recurrence relations, Equations reducible to Bessel's equation, Sturm Liouville's problem, Eigen function expansions.	25

Course Outcomes: By the end of the course, the students will be able to	
1	Formulate and solve linear and nonlinear partial differential equations
2	Apply partial differential equations to engineering problems.
3	Solve differential equations using series solutions.
4	Describe special functions as solutions to differential equations**.**
5	Expand functions in terms of eigenfunctions and to solve Sturm Liouville's problems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Advanced Engineering Mathematics, E. Kreyszig, John Wiley	2006
2	Advanced Engineering Mathematics, Wylie and Barrett, McGraw Hill	**2003**
3	Elements of Partial differential equations, Sneddon, McGraw Hill	**2006**

Course Name	**:**	**NUMERICAL ANALYSIS**

Course Code	**:**	**MAN 109**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to describe errors involved in computations and to estimate these errors. The students should be able to solve equations, apply numerical methods to interpolate, extrapolate, differentiate and integrate functions. They should be able to solve differential equation using numerical methods and solve systems of equations.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**ERRORS** Errors in numerical calculations, Absolute, relative and percentage errors, Round off and truncation errors, Error propagation, Loss of significant digits, Errors in series approximation, Speed of convergence.	5
2	**SOLUTION OF EQUATIONS** Bisection method, Fixed point iteration and its convergence, Acceleration of convergence using Aitken's method; Regula-Falsi, Newton-Raphson, Generalized Newton's, Chebyshev's and Halley's methods.	7
3	**INTERPOLATION** Lagrange Interpolation, Newton's divided difference interpolation, Finite differences, Newton's, Bessel's, Stirling's and Guass' difference formulae.	10
4	**NUMERICAL DIFFERENTIATION & INTEGRATION** Differentiation using differences, Integration using Newton-cote's formulas with errors, Gaussian Quadrature.	8
5	**SOLUTION OF LINEAR SYSTEM OF EQUATIONS** Direct methods - Gauss elimination, Partial pivoting, Complete pivoting, Gauss-Jordan and factorization methods, Iterative methods-Gauss Siedal and Jacobi's methods.	6
6	**NUMERICAL METHODS FOR DIFFERENTIAL EQUATIONS** Solution of first order differential equations using Taylor's series, Euler's, Picard's and Runge-Kutta method upto 4^{th} order, Predictor-Corrector methods (Adam's and Milne's method),	6

Course Outcomes:	
1	Describe errors involved in computations and to estimate the errors.
2	Solve algebraic and transcendental equations using Bisection method Regula-Falsi, Newton-Raphson,
3	Generalized Newton's, Chebyshev's and Halley's methods.
4	Apply numerical methods to interpolate, extrapolate differentiate and integrate functions.
5	Solve systems of equations.
6	Solve differential equation using numerical methods.(Taylor's series, Euler's, Picard's and Runge-Kutta method upto 4^{th} order, Predictor-Corrector methods)

Suggested Books:		
Sr.	**Name of Book/ Authors/ Publisher**	**Year of**

No.		Publication/ Reprint
1	Advanced Engineering Mathematics, E. Kreyszig, John Wiley	2006
2	Numerical Methods for Mathematics, Science and Engineering, Mathews, Prentice Hall	1992
3	An Introduction to Numerical Analysis, Atkinson, John Wiley	2012

Course Name	**:**	**OSCILLATIONS AND OPTICS**
Course Code	**:**	**PYN101**
Credits	**:**	**4**
L T P	**:**	**3 1/2 2/2**

Course Objectives:
To familiarize the students with Ultrasonics and their applications To acquaint the students with simple harmonic motion along with damping and driving forces To refresh the basics of interference, diffraction and polarization and familiarize the students with their applications through lectures and experiments To teach the students the basic concepts of LASER and to familiarize them various kinds of lasers To acquaint the students with fundamentals of holography

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**ULTRASONICS:** Production, detection and uses of ultrasonics, reverberation, sabine's formula (no derivation)	3
2	**SHM:** Review of basic kinematics (displacement, velocity, acceleration, time period and phase of vibration) and dynamics (restoring force and energetics) of simple harmonic motion, differential equation of SHM, superposition of two SHM in one dimension, charge oscillations in LC circuits	4
3	**DAMPED OSCILLATIONS:** Concept and cause of damping, differential equation of a damped oscillator and different kinds of damping, Methods of describing damping of an oscillator - logarithmic decrement, relaxation time, quality factor, band width. Series LCR circuit as a damped oscillator.	4
4	**FORCED OSCILLATIONS:** States of forced oscillations, differential equation of forced oscillator – its displacement, velocity and impedance, behaviour of displacement and velocity with driver's frequency, Power, bandwidth, Quality factor and amplification of forced oscillator, resonance in forced oscillators, forced oscillations in series LCR circuit	5
5	**WAVE MOTION:** Wave equation and its solution, characteristic impedance of a string, reflection and transmission of waves on a string at a boundary, reflection and transmission of energy, the matching of impedances	3
6	**INTERFERENCE:** Division of wave front and amplitude; Fresnel's biprism, Newton's rings, Michelson interferometer and its applications for determination of λ and $d\lambda$.	4
7	**DIFFRACTION:** Fresnel and Fraunhofer diffraction, qualitative changes in diffraction pattern on moving from single slit to double slit, plane transmission grating, dispersive power & resolving power of a grating.	5
8	**POLARIZATION:** Methods of polarization, analysis of polarized light, quarter and half wave plates, double refraction.	4
9	**LASERS:** Elementary idea of LASER production, spontaneous emission, stimulated emission, Einstein's coefficients, Helium-Neon, Ruby and semiconductor lasers, applications of lasers.	4
10	**FIBRE OPTICS:** Basics of optical fibre - its numerical aperture, coherent bundle, step index and graded index fibre, material dispersion, fibre Optics sensors, applications of optical fibre in communication systems.	4
11	**HOLOGRAPHY:** Basic principle, theory and requirements.	2

List of Experiments:	
1	To find the wavelength of sodium light using Fresnel's biprism.
2	(i) To determine the wavelength of He-Ne laser using transmission grating. (ii) To determine the slit width using the diffraction pattern.
3	To determine the wave length of sodium light by Newton's rings method.
4	To determine the wave length of sodium light using a diffraction grating.
5	To find the specific rotation of sugar solution using a Bi-quartz Polarimeter.
6	To design a hollow prism and used it find the refractive index of a given liquid

Course Outcomes:	
1	Students are aware of latest developments in certain areas of Physics which have important applications for societal needs.
2	Students learn about lasers and fibre optics which have important applications for societal needs.
3	Students are expected to develop capability to tackle problems in general and in the various areas covered in the course.

Reference Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	Physics for Engineers (Prentice Hall India) - N.K. Verma
2	Physics of Vibrations and Waves (5th Edition, John Wiley & Sons) – H.J.Pain
3	Optics – Ajoy Ghatak

Course Name	**:**	**CONDENSED MATTER PHYSICS**
Course Code	**:**	**PYN102**
Credits	**:**	**4**
L T P	**:**	**3 1/2 2/2**

Course Objectives:
To teach the students the basic concepts of crystal structure and defects To familiarize the students with the concepts of Free electron theory of metals and its applicability To acquaint the students with the concepts of Dielectric and Magnetics materials with their applications through lectures and experiments To impart to the students the concepts of superconductivity and nanotechnology To teach the students the basic concepts of crystal structure and defects

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**CRYSTAL STRUCTURE:** Space lattices and their symmetries, crystal structures (cubic and hexagonal cells), assignment of coordinates, directions and planes in crystals, linear, planer and space densities in crystals, close packed morphology (Hexagonal and cubic close packing), single and polycrystalline structures, interstitial spaces (trigonal, tetrahedral and octahedral voids, crystal Structure analysis, X-ray diffraction and Bragg's law, crystal defects, Point, line, surface and volume imperfections	(11)
2	**THEORY OF METALS:** Free electron theory, electrical properties, thermal properties, motion in magnetic field (cyclotron resonance), Zone theory. Band theory of solids, Kronig-Penney Model (qualitative), conductors, insulators and semiconductors	(6)
3	**DIELECTRIC MATERIALS:** Review of basic formulas, dielectric constant and polarizability, sources of polarizability, classical treatment of dipolar, ionic and electronic polarizability, piezoelectricity, ferroelectrcity.	(5)

4	**MAGNETIC MATERIALS:** Review of basic formulas, magnetic susceptibility, classification of materials, Langevin diamagnetism, paramagnetism (only classical treatment), magnetism in metals, ferromagnetism in insulators, anti-ferromagnetism and ferrimagnetism, ferromagnetism in metals, ferromagnetic domains, hysteresis	(8)
5	**SUPERCONDUCTIVITY:** Zero resistance, occurrence of superconductivity, Meissner effect, critical field, thermodynamics of superconducting transitions, electrodynamics of superconductors, qualitative idea of BCS theory.	(4)
6	**SEMICONDUCTORS**: p-type and n-type semiconductors, statistics of electrons and holes, Hall effect (for single as well as both type of charge carriers)	(4)
7	**NANOTECHNOLOGY:** Introduction, Synthesis of Nanoparticles: Mechanical Method, Sputtering, Chemical Vapour Deposition, Sol-gel Technique, Applications of Nanotechnology	(4)

List of Experiments:	
1	To find the energy band gap of the given semiconductor by four probe method.
2	To study the Hall Effect of a given semiconductor.
3	To determine the dielectric constant of the given materials.
4	To study the B-H curve of the ferromagnetic materials.
5	To determine the value of e/m for electron by long solenoid (helical) method.
6	To study the variation of magnetic field with distance along the axis of a circular coil carrying current by plotting a graph.

Course Outcomes:	
1	Students learn about dielectric and magnetic materials which have important applications for societal needs.
2	Students learn about superconductivity and nanotechnology which have important applications.
3	Students are expected to develop capability to tackle problems in general and in the various areas covered in the course.

Suggested Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	Material science and Engineering – An Introduction by William D Callister, Jr, Sixth Edition, John Wiley and Sons.
2	Material science and Engineering – A First Course by V.Raghvan Fourth Edition, Eastern Economy Edition
3	Solid State Physics (New Age Publishers) – S.O. Pillai
4	Introduction to Solids (Tata McGraw Hill, Third Edition) - Leonid V Azaroff

Course Name	**:**	**MECHANICS**
Course Code	**:**	**PYN - 105**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
To acquaint about the engineering aspects of Mechanics To familiarize Kinematics and Kinetics of rigid body To inculcate the application of Mechanic concepts in engineering To familiarize the application of relative motion analysis in the design of energy system

Total No. of Lectures – 36

Lecture wise breakup		**Number of Lectures**
1	**KINEMATICS OF A PARTICLE**: Introduction. Rectilinear Kinematics: General	5

	Curvilinear Motion. Curvilinear Motion: Rectangular Components, Normal and Tangential Components, Cylindrical Components. Absolute Dependent Motion Analysis of Two Particles. Relative-Motion Analysis of Two Particles Using Translating Axes. Motion of a Projectile.	
2	**KINETICS OF A PARTICLE: FORCE AND ACCELERATION**: Newton's Laws of Motion. The Equation of Motion. Equation of Motion for a System of Particles. Equations of Motion: Rectangular Coordinates, Normal and Tangential Coordinates, Cylindrical Coordinates. Central-Force Motion and Space Mechanics.	4
3	**KINETICS OF A PARTICLE: WORK AND ENERGY**: The Work of a Force. Principle of Work and Energy. Principle of Work and Energy for a System of Particles. Power and Efficiency. Conservative Forces and Potential Energy. Conservation of Energy.	3
4	**KINETICS OF A PARTICLE: IMPULSE AND MOMENTUM**: Principle of Linear Impulse and Momentum. Principle of Linear Impulse and Momentum for a System of Particles. Conservation of Linear Momentum for a System of Particles. Impact. Angular Momentum. Relation Between Moment of a Force and Angular Momentum. Angular Impulse and Momentum Principles.	4
5	**PLANAR KINEMATICS OF A RIGID BODY:** Rigid-Body Motion. Translation. Rotation About a Fixed Axis. Absolute General Plane Motion Analysis. Relative-Motion Analysis: Velocity, Instantaneous Center of Zero Velocity, Acceleration. Relative-Motion Analysis using Rotating Axes.	4
6	**PLANAR KINETICS OF A RIGID BODY: FORCE AND ACCELERATION:** Moment of Inertia. Planar Kinetic Equations of Motion. Equations of Motion: Translation, Rotation About a Fixed Axis, and General Plane Motion.	4
7	**PLANAR KINETICS OF A RIGID BODY: WORK AND ENERGY:** Kinetic Energy. The Work of a Force. The Work of a Couple. Principle of Work and Energy. Conservation of Energy.	3
8	**PLANAR KINETICS OF A RIGID BODY: IMPULSE AND MOMENTUM:** Linear and Angular Momentum. Principle of Impulse and Momentum. Conservation of Momentum. Eccentric Impact.	3
9	**THREE-DIMENSIONAL KINEMATICS OF A RIGID BODY**: Rotation About a Fixed Point. The Time Derivative of a Vector Measured from a Fixed and Translating-Rotating System. General Motion. Relative-Motion Analysis using Translating and Rotating Axes.	3
10	**THREE-DIMENSIONAL KINETICS OF A RIGID BODY**: Moments and Products of Inertia. Angular Momentum. Kinetic Energy. Equations of Motion. Gyroscopic Motion. Torque-Free Motion.	3

Course Outcomes:	
1	The student will be able to understand the concepts of Mechanics.
2	The students will be able to apply the concepts of Mechanics in fluid of energy.
3	The students will be able to understand various types of motion characteristic and found characteristic of rigid body.

Suggested Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	R.C. Hibbeler, Dynamics (11th Ed) Pearson Publishers.
2	F.P. Beer et al. Dynamics (8th Ed) Mc GrawHill Publishers.
3	Merriam and Kraige; Dynamics (5th Ed) Wiley and Sons Publications Merriam and Kraige.
4	R.C. Hibbeler, Statics (11th Ed) Pearson Publishers.

Course Name	**:**	**ELECTROMAGNETIC THEORY**
Course Code	**:**	**PYN-106**

Credits	**:**	**4**
L T P	**:**	**3 1/2 2/2**

Course Objectives:
At the end of the course, the student should be able to understand the classification of the vector fields. The student should be able to apply the concepts of electrostatics and boundary value problems. The student should be able to understand concepts of electromagnetic wave propagation.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**VECTORS AND FIELDS:** Cartesian coordinate System, Cylindrical and Spherical coordinate Systems, Constant coordinate surfaces, Del operator, Gradient, Divergence of a Vector and Divergence Theorem, Curl of a vector and Stoke's theorem, Gradient, Divergence, Curl and Laplacian in the three coordinate Systems, Laplacian of a scalar, Scalar & Vector Fields, Classification of Vector field. Sinusoidally time-varying fields, Complex Numbers and Phasor technique.	10
2	**ELECTROSTATICS:** Field intensity, Gauss's law & its applications, Maxwell's 1st eqn. (Electrostatics), Electric Energy and potential, the line integral, Potential gradient, the dipole fields, Energy density in an electrostatic field. Current and current density, Continuity of current, Metallic conductors, Conductor properties and boundary conditions, the nature of Dielectric materials and related Boundary conditions, Capacitance, Capacitance of a two-wire line, Current analogies. Electrostatic boundary-value problems, Laplace's and Poisson's equations, Uniqueness theorem, General procedure for solving Laplace's and Poisson's equation , Resistance and capacitance, Method of images.	10
3	**MAGNETOSTATICS:** Biot-Savart's law, Ampere's circuital law, Applications of Ampere's law, Magnetic flux and magnetic flux density-Maxwell's eqn., Maxwell's eqn. for static electromagnetic fields, Scalar and vector magnetic potentials. Magnetic dipole, Force due to Magnetic field on a differential current element, force between two differential current elements, Force and torque on a closed circuit, The nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Inductors and inductances, Magnetic energy, Magnetic circuits, Potential energy and force on magnetic materials.	11
4	**MAXWELL'S EQUATIONS AND ELECTROMAGNETIC WAVE PROPAGATION:** Faraday's law, Displacement current, Maxwell's equations in point form, Maxwell's equations in integral form, Kirchoff's Voltage law and Kirchoff's Current law from Maxwell's equations, EM waves in general, EM wave propagation in Lossy Dielectrics, Wave propagation in lossless dielectrics, Plane waves in free space, Plane waves in Good conductors, Power & Poynting Vector, Reflection of a plane wave at normal incidence, Reflection of a plane wave at oblique incidence.	11

List of Experiments:		**Number of Turns**
1	To design a method to draw equipotential lines with various geometries of electrodes kept at different potentials	1
2	To study the variation of magnetic field with distance along the axis of a circular coil carrying current by plotting a graph	1
3	To find the energy band gap of the given semiconductor by four probe method	1
4	To study the Hall effect of a given semiconductor	1
5	To determine the dielectric constant of the given materials	1
6	To study the B-H curve of the ferromagnetic materials	1

Course Outcomes:	
1	By the end of the course, the student will be equipped with the tools of electromagnetic theory.
2	The student will be able to solve numerical problems based on vector fields, electrostatics, magnetostatics and electromagnetic wave propagation.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Engineering Electromagnetics, William H Hyat, Jr., and John A. Buck, Tata McGraw Hill	2013 / 5th edition
2	Elements of Engineering Electromagnetics, Matthew N.O. Sadiku, Oxford University Press	2012 / 4th edition
3	Introduction to Electrodynamics, D.J. Griffiths, Prentice Hall	2012 / 4th edition

Course Name	**:**	**APPLIED CHEMISTRY**
Course Code	**:**	**CHN101**
Credits	**:**	**4**
L T P	**:**	**3 0 3**

Course Objectives: Upon completion of this course, students will have fundamental knowledge of the following:
Concepts of water and its analysis, polymer chemistry, solid state chemistry, lubricants, coordination chemistry and substitution reactions as applied to various industries. Spectroscopic methods required for the characterization of engineering materials. Design and development of novel future engineering materials and processes. Experiments related to applications of analysis and chemical processes relevant to various Industries.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**WATER TREATMENT AND ITS ANALYSIS:** Boiler feed water and its problems, Water Softening techniques, Domestic Water treatment, Chemical Analysis and related numerical problems	7
2	**POLYMER CHEMISTRY:** Classification, Mechanism and methods of polymerization, preparation, properties and uses of few engineering.	5
3	**SOLID STATE CHEMISTRY**: Introduction to structure and bonding-ionic solids, crystal defects and applications of defect structure (transistors, rectifiers, photovoltaic cells and computer chips).Introduction to ceramics.	6
4	**LUBRICANTS/ FUEL CELL TECHNOLOGY/CORROSION:** Functions mechanism, classification, properties and analysis of Lubricants and related numerical problems. Introduction to electrochemistry, types of electrodes, Reference electrodes, Ion-selective electrodes, Concentration cells, Batteries, Fuel cells/ Types of corrosion, dry and wet corrosion and their mechanisms, types of electrochemical corrosion, factors influencing corrosion, Prevention of corrosion.	6
5	**ATOMIC AND MOLECULAR SPECTROSCOPY: AAS**- Principle, instrumentation and applications of UV,IR and NMR spectroscopy and related problems.	10
6	**COORDINATION CHEMISTRY:** Crystal Field Theory, Splitting of octahedral, tetrahedral and square planner complexes, Applications of crystal field theory.	4
7	**AROMATIC ELECTROPHILIC AND NUCLEOPHILIC SUBSTITUTION:** Reaction mechanisms and applications.	4

Course Outcomes: Students who complete the course will have demonstrated the ability to do the following:	
1	Apply the knowledge for water treatment and its analysis for processing and its disposal which is relevant to all Industries for efficient utilization of water as an essential industrial resource.
2	Develop and design new materials based on knowledge of polymers, solid chemistry and substitution reactions
3	Hands on experience for carrying out experiments with precision for characterization and estimation of materials by wet analysis.
4	Will be able to carry out Instrument based spectroscopic analysis of new materials and interpretation of relevant data.

Reference Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	Atkin's Physical Chemistry by Peter Atkins, Julio de Paula, 7th Edition, Oxford University Press.
2	Concise Inorganic Chemistry Vth Edition J D Lee 2003 (Chapman & Hall)
3	A Textbook of Engineering Chemistry by Shashi Chawla, Dhanpat Rai& Co. Pvt. Ltd.
4	Introductory Polymer Chemistry by G.S.Mishra, John Wiley & Sons, New York, 1993.
5	Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and P.L. Gaus, 3rd Ed., John Wiley & Sons.
6	Puri, Sharma and Pathania : Principles of Physical Chemistry, W.H. Freeman & Co, 2008.
7	Organic Chemistry by Joseph M.Hornback Brooke/Cole Publishing Company U.S.A.
8	D. S. Pavia, G.M. Lasmpman and G.S. Kriz : Introduction to Spectroscopy, 4th Edition, Thomson learning, Indian Edition 208.
9	Chemistry for environmental engineering by C. N. Sawyer, P. McCarty, G. F. Parkin, Mc Graw Hill Inc, New York.

Course Name	**:**	**PHYSICAL CHEMISTRY**
Course Code	**:**	**CHN-102**
Credits	**:**	**4**
L T P	**:**	**3 0 3**

Course Objectives:
At the end of this course the students should be able to describe and implement concepts and principles of Physical Chemistry required for indepth understanding of Physical phenomena of materials in relation to applications in Engineering .

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**CHEMICAL EQUILIBRIUM :** General characteristics of chemical equilibrium, thermodynamic derivation of the law of chemical equilibrium, Van't Hoff reaction isotherm. Relation between Kp, Kc and Kx. Temperature dependence of equilibrium constant-Van't Hoff equation, Le Chatelier's principle.)	4
2	**SOLUTIONS**: Ideal and non-ideal solutions, Raoults's law, change of free energy, enthalpy, and entropy on mixing of liquids, distillation of binary solutions. Partially miscible liquids such as Phenol- water, triethylamine- water, and Nicotine- water systems. Henry's law, Nernst distribution law, Colligative properties of dilute solutions. Abnormal molar mass, degree of dissociation and association of solutes.	8
3	**CHEMICAL KINETICS:** Rate equation of reactions of various orders, rate mechanism, kinetics of complex reactions. Concept of energy barrier and energy of activation. Theories of reaction rates, measurement of extent of reaction, zero order reactions. Rates of flow systems. Lindemann theory of unimolecular reactions.	8

4	**SURFACE PHENOMENA:** Adsorption of gases by solids. Types of adsorption, adsorption isotherms, Langmuir's adsorption equation, B.E.T. equation for determination of surface area of adsorbents, applications of adsorption, catalysis, kinetics of surface reactions. Introduction to micelles, emulsions and gels.	6
5	**PHASE EQUILIBRIA** : Phase rule and its thermodynamic derivation. One component systems-water, sulphur, Two component systems, construction and interpretation of general phase diagrams for liquid-vapour, liquid-liquid and liquid-solid systems. Eutectics, freezing mixtures, ultra purity, zone refining.	6
6.	**ELECTROCHEMISTRY:** Conductance of electrolytic solutions, transference number and its determination, Kohlrausch's law of independent migration of ions, Interionic attraction theory, activity and activity coefficients of strong electrolytes, ionic equilibria. Ionizaton of water, ionization constants of weak acids and weak bases, hydrolysis, pH, common ion effect, solubility product and salt effect.	5
7.	**ELECTROCHEMICAL CELLS:** Reversible and irreversible cells, e.m.f. and its measurement, cell reactions and e.m.f., thermodynamics of electrode potentials, half- cell potential and its determination, Nernst equation, concentration cells, liquid junction potential, determination of activity co-efficient from cell potential data, potentiometric titrations.	4

List of Experiments:		**Number of Turns**
1	Determination of Surface tension of liquids using Stalagmometer.	2
2	Distribution of Iodine between water and carbon tetrachloride.	2
3	Kinetics of the hydrolysis of methyl acetate in the presence of hydrochloric acid.	3
4	Adsorption of acetic acid on activated charcoal.	2
5	Conductometric and Potentiometric titrations and Colorimetry.	4

Course Outcomes: By the end of this course, the student will be able to-	
1	Understand the phenomenon of chemical equilibrium, phase equilibria and effect of change of process parameters such as T, P, C etc both quantitatively and qualitatively.
2	Understand physical properties of solutions like change of free energy, entropy of mixing as applies to heat and mass transfer in chemical processes.
3	Analyse the kinetics of chemical processes that are useful in the design of reactors and optimisation of material processing and its implementation.
4	Apply concepts of various surface phenomenons for material coatings, separate technology and in catalytic processes.
5	Design the sensors based on the concepts of electrochemistry.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Principles of Physical Chemistry by Maron, Samuel H. Prutton, ; Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.	2002
2	Textbook of Physical Chemistry by Carl F. Glasstone, Samuel ; MacMillan and Co. Ltd. London	2010
3	Principles of Physical Chemistry by B.R Puri., L.R Sharma, and Pathania, S Madan,; S. Nagin &Co Jalandhar.	2013
4	Chemical Kinetics by Laidler , J Keith ;Tata McGraw-Hill Co. Ltd., New Delhi.	2002
5	A Text Book of Physical Chemistry by P.W Atkins; Oxford University Press.	2009
6	Findlay's Practical Physical Chemistry by B.P Lavitt. ; Longman Group Ltd.	1973

Course Name	**:**	**INORGANIC CHEMISTRY**
Course Code	**:**	**CHN-103**
Credits	**:**	**4**
L T P	**:**	**3 0 3**

Course Objectives: Upon completion of this course, students will have fundamental knowledge of the following:
Concepts of structure and chemical bonding essential for understanding of molecular structure. Solid state chemistry for application in electronics, ceramics and other advanced materials. Magnetic behaviour and catalytic properties of co-ordination and organometallic compounds used in various industries. Interaction and role of metals in biological systems essential for bio-engineering applications.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**QUANTUM THEORY AND ATOMIC STRUCTURE:** Introduction to wave mechanics, the Schrodinger equation, the Schrodinger equation as applied to hydrogen atom, the origin of quantum numbers and shapes of orbitals.	4
2	**CHEMICAL BONDING:** Molecular orbital and valence bond theories of bond formation and application of molecular orbital theory to the formation of homonuclear and heteronuclear diatomic molecules.	7
3	**THE SOLID STATE:** A recapitulation of close packing of spheres, structures of NaCl, CsCl, ZnS, CaF2, crystal defects and applications of defect structures (transistors, rectifiers, photovoltaic cells and computer chips).	4
4	**COORDINATION COMPOUNDS:** Part 1:Werner's theory, effective atomic number, bonding of transition metal complexes: valence bond theory, crystal field theory, crystal field splitting in tetrahedral, octahedral and distorted octahedral (square planar) crystal fields. Thermodynamic aspects of coordination compounds (crystal field stabilization energies of octahedral and tetrahedral complexes, spectrochemical series).	6
5	**COORDINATION COMPOUNDS:** Part2: Kinetic aspects of coordination compounds (substitution reactions in complexes with coordination number 4 and 6 and their mechanism - **SN^1**, SN^2). Magnetic behaviour of complexes – Para magnetism, diamagnetism, ferromagnetism and antiferromagnetism and measurement ofmagnetic susceptibility of complexes by Guoy's method.	6
6	**ORGANOMETALLIC COMPOUNDS:** Nomenclature, types of ligands and bonding in organometallic compounds, use of organometallics in industry.	5
7	**INORGANIC POLYMERS: TYPES** of inorganic polymers, polyphosphazenes, polysiloxanes –their structures and properties.	5
8	**ROLE OF METALS IN BIOLOGICAL SYSTEMS:** Bio-inorganic Chemistry of Iron – Heme proteins & Non-Heme iron proteins; bioinorganic chemistry of cobalt-vitamin B12 and metalloenzymes.	5

Course Outcomes: Students who complete the course will have demonstrated the ability to do the following:	
1	Apply the knowledge of quantum theory, chemical bonding and solid state, to know the structure and bonding required for the development of new materials.
2	Design new inorganic materials with desired physical and chemical properties.
3	Carry out experiments with precision related to synthesis and characterization of new industrially important inorganic materials.

Reference Books:	
Sr. No.	**Name of Book/ Authors/ Publisher**
1	Sharpe, A. G. : Inorganic Chemistry, 3rd Edition, Longman Publishers ELBS, 1992.
2	Lee, J. D. : Concise: Inorganic Chemistry, 5th Edition, Chapman and Hall Publishers, 1996.
3	Cotton, F. A. & Wilkinson, G. : Advanced Inorganic Chemistry, 3rd Edition,Wiley Eastern Ltd., 1982.

4	Cotton, F. A. & Wilkinson, G. : Basic Inorganic Chemistry, Wiley EasternLtd., 1987. 12
5	Mark, J., West, R. & Allcock,H. : Inorganic Polymer, Prentice Hall, New Jersey Publishers, 1982.

Course Name	**:**	**PHYSICAL CHEMISTRY**
Course Code	**:**	**CHN-104**
Credits	**:**	**4**
L T P	**:**	**3 0 3**

Course Objectives:

Concepts of chemical equilibria, solutions, chemical kinetics and electrochemistry to the physical phenomena occurring in various chemical processes.
Surfaces modification of important industrial materials used in adsorption and separating technology.
Phase equilibria for understanding the physical behaviour of various materials such as alloys and other biphasic and triphasic systems.
Experiments related to the theoretical studies of different physical phenomena relevant to various industries.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**CHEMICAL EQUILIBRIUM:** thermodynamic derivation of the law of chemical equilibrium, Van't Hoff reaction isotherm. Relation between Kp, Kc and Kx. Temperature dependence of equilibrium constant- Le Chatelier's principle.	5
2	**SOLUTIONS:** Raoults's law, change of free energy, enthalpy, and entropy on mixing of liquids, distillation of binary solutions. Partially miscible liquids Henry's law, Nernst distribution law, Colligative properties of dilute solutions. Abnormal molar mass, degree of dissociation and association of solutes.	8
3	**CHEMICAL KINETICS**: Rate equation of various orders, rate mechanism, kinetics of complex reactions. Theories of reaction rates, measurement of extent of reaction, Rates of flow systems. Lindemann theory of unimolecular reactions.	8
4	**SURFACE PHENOMENA**: Adsorption of gases by solids., adsorption isotherms., Langmuir's adsorption equation, B.E.T. equation for determination of surface area of adsorbents, applications of adsorption, catalysis, kinetics of surface reactions. Introduction to micelles, emulsions and gels.	6
5	**PHASE EQUILIBRIA** : Phase rule and its thermodynamic derivation. One component systems-water, sulphur, Two component systems, construction and interpretation of general phase diagrams for liquid-vapour, liquid-liquid and liquid-solid systems. Eutectics, freezing mixtures, ultra purity, zone refining.	6
6	**ELECTROCHEMISTRY:** transference number and its determination, Kohlrausch's law of independent migration of ions, Interionic attraction theory, activity and activity coefficients of strong electrolytes, ionic equilibria. Ionizaton of water, ionization constants of weak acids and weak bases, common ion effect, solubility product and salt effect.	5
7	**ELECTROCHEMICAL CELLS**: Reversible and irreversible cells, e.m.f. and its measurement, cell reactions and e.m.f., thermodynamics of electrode potentials, half- cell potential and its determination, Nernst equation, concentration cells, liquid junction potential, determination of activity co-efficient from cell potential data, potentiometric titrations.	4

Course Outcomes: Students who complete the course will have demonstrated the ability to do the following:	
1	Understand the relevance of the physical phenomena occurring in various materials and processes.
2	Modify the composition of various materials required for new technological applications.
3	Hands on experience for carry out experiments with precision related to chemical equilibria, surface phenomena and reaction kinetics required for designing various processes in Industry.

Suggested Books:	
Sr.	**Name of Book/ Authors/ Publisher**

No.	
1	Maron, Samuel H. Prutton, Principles of Physical Chemistry, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
2	Carl F. Glasstone, Samuel Textbook of Physical Chemistry, MacMillan and Co. Ltd. London.
3	Puri,B.R.,Sharma,L.R.and Pathania,Madan,S. Principles of physical chemistry, S.Nagin & co Jalandhar.
4	Laidler, Keith J. Chemical Kinetics, Tata McGraw-Hill Co. Ltd., New Delhi.
5	Atkins, P.W. A Text Book of Physical Chemistry,Oxford University Press.

HUMANITIES, SOCIAL SCIENCES AND MANAGEMENT COURSES (HSSMEC)

Course Name	**:**	**ETHICS AND SELF AWARENESS**
Course Code	**:**	**HSS 101**
Credits	**:**	**2**
L T P	**:**	**2-0-0**

Course Objectives:
To provide basic knowledge about ethics, values, norms and standards and their importance in real life. To improve the personality of students by their self-assessment

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO ETHICS** Concept of Ethics – Nature, Scope, Sources, Types, Functions and Factors influencing Ethics, Approaches to Ethics – Psychological, Philosophical and Social, Broader Ethical Issues in Society	**6**
2	**VALUES, NORMS, STANDARDS AND MORALITY** Concept and Role, Relation with Ethics, Psycho-Social Theories of Moral Development – Kohlberg and Carol Gilligan	**4**
3	**ETHICS AND BUSINESS** Concept of Business Ethics – Nature, Objectives and Factors influencing Business Ethics, 3 C's of Business Ethics, Ethics in Business Activities, Ethical Dilemmas in Business, Managing Ethics	**5**
4	**SELF-AWARENESS** Concept of Self Awareness – Need, Elements, Self Assessment – SWOT Analysis, Self Concepts – Self-Knowledge, Assertiveness and Self-Confidence, Self-Esteem	**4**
5	**SELF-DEVELOPMENT** Concept of Self-Development, Social Intelligence, Emotional Intelligence, Managing Time and Stress, Positive Human Qualities (Self-Efficacy, Empathy, Gratitude, Compassion, Forgiveness and Motivation), Personality Development Models – Johari Window, Transactional Analysis, Myers Briggs Type Indicator, Self-Awareness and Self-Development Exercises	**9**

Course Outcomes:	
1	Helps to distinguish between right and wrong in both personal and professional life
2	Students learn about their strengths, weaknesses, opportunities & threats and work enthusiastically to transform weaknesses into strengths and threats into opportunities

Reference Books:	
1	Murthy, C.S.V., "Business Ethics – Text and Cases", Himalaya Publishing House
2	Hartman, Laura P. and Chatterjee, Abha, "Business Ethics", Tata McGraw Hill
3	Rao, A.B., "Business Ethics and Professional Values", Excel Books
4	Velasquez, Manuel G., "Business Ethics – Concepts and Cases", Prentice Hall
5	Corey, G., Schneider, Corey M., and Callanan, P., "Issues and Ethics in the Helping Professions", Brooks/Cole
6	Hall, Calvin S., Lindzey, Dardner and Cambell, John B., "Theories of Personality", Hamilton Printing Company
7	Leary, M.R., "The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Oxford University Press

Course Name	**:**	**COMMUNICATION SKILLS (BASIC)**

Course Code	**:**	**HSS 102**
Credits	**:**	**2**
L T P	**:**	**1-0-2**

Course Objectives:
The main aim of the course is to build competence in English grammar and vocabulary and to enhance effective communication by developing Reading, Writing, Listening and Speaking skills of students.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**FUNDAMENTALS OF COMMUNICATION SKILLS** Scope and Significance of Communication Skills, Listening, Speaking, Reading and Writing	**3**
2	**WRITING SKILLS** Basics of Grammar – Placing of Subject and Verb, Parts of Speech, Uses of Tenses, Active-Passive, Narration	**3**
3	**VOCABULARY BUILDING AND WRITING** Word Formation & Synonyms, Antonyms, Words Often Confused, One-Word Substitutes, Idioms and Phrasal Verbs, Abbreviations of Scientific and Technical Words	**3**
4	**SPEAKING SKILLS** Introduction to Phonetic Sounds & Articulation, Word Accent, Rhythm and Intonation	**3**
5	**READING AND COMPREHENSION** Two comprehensive prose passages	**2**

List of Experiments:		**Number of Turns**
1	Introducing Oneself, Exercise on Parts of Speech & Exercise on Tense	**2**
2	Exercise on Agreement, Narration, Active Passive Voice & Dialogue Conversation	**2**
3	Exercise on Writing Skills and Listening Comprehension (Audio CD)	**2**
4	Practice of Phonemes, Word Accent, Intonation, JAM Session	**2**
5	Individual Presentation, Extempore and Picture Interpretation	**2**
6	Vocabulary Building Exercises (One Word Substitute, Synonyms, Antonyms, Words Often Confused etc.) & Group Discussion	**2**
7	Reading Comprehension & Organizational Correspondence and Debate	**2**

Course Outcomes:	
1	The students will be able to perform better in their academic and professional life.
2	The student will gain self-confidence with improved command over English.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"The Essence of Effective Communication", Ludlow R. and Panton F., Pubs: Prentice Hall.	1992
2	"A University Grammar of English", Quirk R. and Sidney G., 3rd Edition, Pubs: Pearson Education.	2008
3	"High School English Grammar", Wren and Martin, Pubs: S. Chand & Company Ltd.	2007
4	"Essentials of Business Communication", Guffrey M.E., 8th Edition, Pubs: South-Western College Publishing.	2009
5	"Technical Communication: Principles and Practice", Raman M. and Sharma S., 2nd Edition, Pubs: Oxford University Press.	2012
6	"Effective Business Communication", Rodrigues M.V., Pubs: Concept Publishing Company, Delhi.	2003
7	"English Vocabulary in Use", McCarthy M. and Felicity O' Dell, 2nd Edition, Pubs:	2010

	Cambridge University Press.	
8	"The Pronunciation of English", Jones D., Pubs: Universal Book Stall.	1992

Course Name	**:**	**COMMUNICATION SKILLS (ADVANCED)**
Course Code	**:**	**HSS 103**
Credits	**:**	**2**
L T P	**:**	**1-0-2**

Course Objectives:
The main aim of the course is to enhance communication skills of students for better performance in professional life and to improve their overall personality with the use of advanced techniques in speaking and writing and also to train them in using both verbal and non-verbal communication effectively.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO COMMUNICATION PROCESS** Scope, Significance, Types and Levels, Technical Communication, Tools of Effective Communication	**3**
2	**SPEAKING SKILLS AND PERSONALITY DEVELOPMENT** Interpersonal Communication, Oral Presentation, Body Language and Voice Modulation (Para linguistics and Non- Verbal), Negotiation and Persuasion, Group Discussion, Interview Techniques (Telephonic and Video Conferencing)	**6**
3	**ADVANCED Technical Writing** Job Application, CV Writing, Business Letters, Memos, Minutes, Notices, Report Writing & Structure, E-mail Etiquette, Blog Writing	**4**
4	**COMMUNICATION AND MEDIA** Social and Political Context of Communication, Recent Developments in Media	**1**

List of Experiments:		**Number of Turns**
1	**ORGANIZATIONAL COMMUNICATION** Verbal and Non-Verbal Communication at different levels of organization, Role Play, Case Studies	**2**
2	**SPEAKING TECHNIQUES** Mock Interviews, Participation in Group Discussions, Making and Presenting Power Point	**4**
3	**STANDARD ENGLISH & PRACTICE SESSION** Intonation and Pronunciation, Exposure to Standard English, Sounds, Stress and Rhythm, Comprehension on British and American English	**4**
4	**PRACTICE ON TECHNICAL WRITING** Writing Letters, Memos, Minutes, CV, Job Applications, Reports and e-mails	**4**

Course Outcomes:	
1	The students will gain proficiency in English language for both professional and personal life.
2	The students will learn technical aspects of communication for better performance in extra-curricular activities, recruitment process and prospective jobs.
3	The students will be able to refine their personality through a grip over advanced techniques of language.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**

1	"Effective Technical Communication", Rizvi M.A., 5th Reprint, Pubs: McGraw Hill Education (India).	2007
2	"Technical Communication: Principles and Practice", Raman M. and Sharma, S., 2nd Edition, Pubs: Oxford University Press.	2012
3	"Business Communication Today", Bovee C.L. and Thill J.V., 9th Edition, Pubs: Pearson Education Asia, New Delhi.	2009
4	"Business Correspondence and Report Writing", Sharma R.C. and Mohan K., Pubs: McGraw Hill	1994
5	"Communication for Professional Engineers", Scott B., 2nd Edition, Pubs: Thomas Teleford Ltd.	1997
6	"Handbook for Technical Writing", McMurrey D.A. and Buckley J., Pubs: Cengage Learning.	2012
7	"Student Activities for taking charge of your Career Direction and Job Search", Lock R., 3rd Edition, Pubs: Cole Publishing	1996
8	"The Definitive Book of Body Language", Pease A. and Pease B., Pubs: Manjul Publishing House Pvt. Ltd.	2005

Course Name	**:**	**ECONOMICS**
Course Code	**:**	**HSS 201**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:

The main aim of this course is to make students understand how society manages its scarce resources for achieving maximum satisfaction and to make them learn about economic aspects related to a consumer, firm, market and economy.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO ECONOMICS** Nature of Economics, Economic Thoughts, Economic Activities, Relationship of Economics with other Social Sciences and Engineering	**3**
2	**THEORY OF CONSUMER BEHAVIOUR** Demand: Types, Law of Demand, Demand Supply Curve, Determinants of Demand and Change in Demand (Movement of Demand and Shift of Demand) with Case Studies Elasticity of Demand: Nature, Degrees, Types, Factors Affecting Elasticity of Demand and its Application in present scenario Laws of Consumption: Concept and Applicability of Law of Diminishing Marginal Utility and Law of Equi-Marginal Utility	**9**
3	**THEORY OF PRODUCTION AND COST** Cost: Concept and Types Production: Concept, Scale of Production, Law of Variable Proportion Returns to Factor and Returns to Scale: Causes and Implications Economies and Diseconomies of Scale: Concept and Types Relevance of Production and Cost Concept in present context	**5**
4	**THEORY OF MARKET** Market: Concept and Types (Perfect Competition, Monopoly and Monopolistic Competition), Nature and Relevance of different Markets in present scenario – Case Study	**5**
5	**BASIC CONCEPTS OF MACRO ECONOMICS** National Income: Concept and Measurement Methods, Determination of Equilibrium of Income	**6**

	Inflation: Concept, Causes and Effect of Inflation, Measures to Control Inflation, Case Study on Impact of Inflation	

Course Outcomes:	
1	The students are expected to apply engineering knowledge to maximize profit, satisfaction and welfare.
2	The students are able to identify the forces that affect the economy.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Modern Economics", Ahuja H. L., Pubs: Sultan Chand and Co. Ltd, New Delhi.	2012
2	"Economics For Engineers", Gupta M. L. and Gupta S.P., Pubs: ESS PEE Publications.	
3	"Business Economics", Ahuja H. L., Pubs: Sultan Chand and Co. Ltd, New Delhi.	2010
4	"Macro Economic Theory", Jhingan M.L., Pubs: Konark Publisher Pvt. Ltd., New Delhi.	1986
5	"Principles of Microeconomics", Stiglitz J.E. and Walsh C.E., 4th Edition, Pubs: W.W. Norton & Company.	2006
6	"Principles of Macroeconomics", Stiglitz J.E. and Walsh C.E., 4th Edition, Pubs: W.W. Norton & Company.	2006
7	"Principles of Economics", Mankiw N.G., 7th Edition, Pubs: Cengage Learning	2014
8	"Economics", Samuelson P.A. and Nordhaus W.D., 18th Edition, Pubs: McGraw Hill.	2004

Course Name	**:**	**PSYCHOLOGY**
Course Code	**:**	**HSS 202**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:
The main aim of the course is to provide knowledge and understanding about important concepts in Psychology which will help the students in learning the applications of principles of psychology in personal and professional life.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO PSYCHOLOGY** Concept, Nature and Scope Methods of Studying Human Behaviour – Introspection Method, Observation Method, Experimental Method, Case History Method, Survey Method, Psychological Test Use Relevance of these Methods in present context	**4**
2	**INTELLIGENCE** Concept and Determinants of Intelligence Theories of Intelligence and its Application: Spearman, Thurston, Guilford.	**4**
3	**PERSONALITY** Personality: Concept, Determinants of Personality, Trait Paradigm (Eysenck), Psychodynamic Paradigm (Freud), Measurement of Personality – Self Report Measures (EPQ), Projective Measures (TAT), Hypothetical Measurement of Personality	**4**
4	**MENTAL HEALTH AND STRESS** Mental Health: Concept and Factors Affecting Mental Health Stress: Nature, Rections to Stress, Outcomes of Stress, Stress Management Case Study	**4**

5	**LEARNING AND MEMORY** Learning: Concept, Reinforcement Principle and Learning, Managerial Implications Memory: Concept, Long Term Memory, Short Term Memory, Episodic Memory, Methods to Improve Memory	**3**
6	**MOTIVATION** Nature and Types of Motivation: Extrinsic and Intrinsic Theories of Motivation and its Application: Humanistic and Need Theories Factors Affecting Motivation	**3**
7	**GROUP BEHAVIOUR AND DYNAMICS** Concept and Importance, Types of Groups, Group Development, Group Performance Factors, Conflict: Nature, Conflict Resolution, Case Study	**4**
8	**LEADERSHIP** Leadership: Nature and Importance, Leadership Styles: Authoritarian, Democratic, Paternalistic, Laissez faire, Transactional, Transformational, Case Study	**2**

Course Outcomes:	
1	The students will learn the causes and dynamics of human behavior.
2	The students will be able to apply psychological principles to enhance their personal and professional life.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Psychology", Ciccarelli S.K. and Meyer G.E., Pubs: Pearson India.	2007
2	"Introduction to Psychology", Morgan C.T., Weiss J.R., King R.A. and Schopler J., 7th Edition, Pubs: McGraw-Hill Education.	2004
3	"An Introduction to Psychology", Mangal S.K., 1st Edition, Pubs: Sterling Publishers Pvt. Ltd., New Delhi.	2009
4	"Fundamentals of Social Psychology", Baron R.A., Branscombe N.R., Byrne D. and Bhardwaj G., 1st Edition, Pubs: Pearson India.	2011
5	"Organizational Behaviour", Parikh M. and Gupta R., Pubs: McGraw Hill Education.	2010
6	"Organizational Behavior", Robbins S.P., Pubs: Prentice Hall of India.	2003

Course Name	**:**	**SOCIOLOGY**	
Course Code	**:**	**HSS 203**	
Credits	**:**	**3**	
L T P	**:**	**2-1-0**	

Course Objectives:

The main aim of the course is to make the students understand the role of theory in social sciences and to explain them how social problems interact and react with the larger society. This course also intends to make them learn whether the problem is evaluated on the macro or micro perspective and their cause and effect patterns.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO SOCIOLOGY** Sociology as a Science, Impact of Industrial and French Revolution on the Emergence of Sociology, Contribution of Karl Marx, Emile Durkheim, Max Weber, Alwin Toeffler to Sociology and its Application in present scenario, Relevance of Sociology for Engineering	**5**
2	**BASIC CONCEPTS** Society, Association, Institution, Culture Relativism, Social Structure, Social System,	**2**

	Socialization, Competition, Conflict, Accommodation, Social Mobility	
3	**SOCIETY AND ECONOMY** Evolution of Society: Primitive, Agrarian, Industrial and Post-Industrial, Economic Systems of Simple and Complex Societies, Sociological Dimensions of Economic Life, Market (free) Economy and Controlled (planned) Economy	**4**
4	**INDUSTRIAL SOCIOLOGY** Nature and Scope of Industrial Sociology, Pre-Conditions and Consequences of Industrialization, Impact of Automation and Industrialization on Society with Case Study	**3**
5	**SCIENCE AND TECHNOLOGY** Ethos of Science and Social Responsibility of Science	**2**
6	**SOCIAL CHANGE** Theories of Change and its Application to Sociology, Factors of Change, Directed Social Change, Social Policy and Social Development, Social Cost Benefit Analysis, Role of Engineers in Development	**4**
7	**INDIAN SOCIETY** Traditional Hindu Social Organization, Caste System, Agrarian Society in India, Social Consequences of Land Reforms and Green Revolution, Working of the Democratic Political System in a Traditional Society, Problem of Education in India, Gender Discrimination, Economic Reforms: Liberalization, Privatization and Globalization, Strategies for Development in India, Case Studies	**6**
8	**SOCIAL PROBLEMS** Concept of AIDS, Alcoholism, Drug Addiction, Corruption with Case Study	**2**

Course Outcomes:	
1	The students will be able to identify the function and application of sociology theory in social sciences.
2	The students will be able to understand how social class affects individual life chances.
3	The students will learn about social structure and how it shapes and influences social interactions.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Sociology: Themes and Perspective", Haralambos M. and Holborn M., Pubs: Collins Educational Publications.	2008
2	"Sociology of Indian Society", Rao C.N.S., 2nd Edition, Pubs: Sultan Chand and Co., New Delhi.	2004
3	"Introduction to Sociology", Bhushan V. and Sachdeva D.R., Pubs: Kitab Mahal Publications.	2002
4	"An Introduction to Sociology", Dassgupta S. and Saha P., Pubs: Dorling Kindersley (India) Pvt. Ltd.	2012
5	"Social Change in Modern India", Srinivas M.N., 1st Edition, Pubs: Orient Longman.	2010
6	"Sociology and Modern Social Problems", Ellwood C.A., Pubs: Bastian Books.	2008
7	"Industrial Sociology", Singh N., 1st Edition, Pubs: McGraw Hill Education (India).	2012
8	"Society in India: Concepts, Theories and Recent Trends", Ahuja R., 1st Edition, Pubs: Rawat Publications.	2011

Course Name	**:**	**FRENCH**
Course Code	**:**	**HSS 204**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:

The main aim of this course is to introduce students with basics of a foreign language and make them learn how to communicate in a new language.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	Introductions: introduce yourself or someone else	**2**
2	Greetings	**2**
3	Alphabet / numbers	**3**
4	Communication in a class	**3**
5	Asking and answering basic questions: name – age – nationality – profession – family, friends, acquaintances	**3**
6	Giving the date / day / season / time / frequency of an event	**2**
7	Locating a place / describing a city or a locality / giving information about one's region, city or country	**4**
8	Expressing quantities	**2**
9	Expressing one's preferences / talk about one's leisure time activities	**3**
10	Describing a person / talking about his/her nature	**4**

Course Outcomes:	
1	The students will be able to express themselves in the foreign language.
2	The students will be able to make use of this language in their professional life in the globalized world.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Learn French Through English in 30 Days", Chopra B., 1st Edition, Pubs: Diamond Books.	2009
2	"Complete French", Graham G., Pubs: Hodder & Stoughton.	2012
3	"French Made Easy", Verma R., 1st Edition, Pubs: Goodwill Publishing House, New Delhi.	2012
4	"Learn French for Beginners", Schell R., Pubs: Maanu Graphics.	
5	"French Made Easy", Khan F., Pubs: Lotus Press.	2010
6	"French Course Grammar", Bertenshaw T.H., 1st Edition, Pubs: Orient Blackswan.	1998

Course Name	**:**	**PRINCIPLES OF MANAGEMENT**
Course Code	**:**	**HSM 401**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:
The main aim of this course is to make students understand the management process and principles along with its application in practical life and to help them manage different jobs and situations with the help of management functions.

Total No. of Lectures – 28

Lecture wise breakup		Number of Lectures
1	**INTRODUCTION TO MANAGEMENT** Nature of Management: Art or Science, Principles and Functions of Management	3
2	**EVOLUTION OF MANAGEMENT THOUGHT** Classical Theories: Bureaucratic, Scientific and Administrative Approach Neo-Classical Theories: Human Relations and Human Behaviour Approach Modern Theories of Management Relevance of Management Thought in present scenario – Management Cases	6
3	**PLANNING** Nature of Planning, Planning Process, Application of Planning Process in a Hypothetical Situation, Types of Planning, Types of Plans, Management by Objective (MBO)	4
4	**ORGANIZING** Concept of Organization, Departmentation, Forms of Organization Structure Analysis of Organization Structure – Case Studies Hypothetical Formation of an Organization	4
5	**STAFFING** Human Resource Planning: HRP Process, Job Analysis: Job Description, Job Specifications and Used of Job Analysis Recruitment: Sources and Methods Selection: Selection Process, Role Playing and Case Study on Selection Tests and Interviews Training and Development: Techniques, Performance Appraisal: Methods Case Study on Staffing Practices	6
6	**DIRECTING** Concept, Leadership: Importance and Styles, Motivation: Theories and their relevance in present scenario, Communication: Process, Types and Barriers of Communication Management Game on Leadership, Motivation and Communication	3
7	**CONTROLLING** Nature and Process of Controlling, Requirements for Effective Controlling	2

Course Outcomes:	
1	The students will be able to apply management concepts and principles in daily life and thus, will be able to manage things efficiently and effectively.
2	The students will learn how to get work done easily by using management knowledge and functions.

Suggested Books:		
Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Principles and Practices of Management", Rao V.S.P. and Narayana P.S., Pubs: Konark Publishers.	1987
2	"Principles & Practice of Management", Prasad L.M., 8th Edition, Pubs: Sultan Chand & Sons.	2012
3	"Essentials of Management: International and Leadership Perspective", Weihrich H. and Koontz H., 9th Edition, Pubs: McGraw Hill.	2012
4	"The New Era of Management", Daft R.L., 11th Edition, Pubs: Cengage Learning.	2014
5	"Management: Text and Cases", Rao V.S.P. and Krishna V.H., Pubs: Excel Books.	2008
6	"Fundamentals of Management: Essential Concepts and Applications", Robbins S.P, DeCenzo D.A., Bhattacharya S. and Agarwal M.N., 6th Edition, Pubs: Pearson India.	2009

Course Name	**:**	**BUSINESS ENVIRONMENT AND BUSINESS LAWS**
Course Code	**:**	**HSM 402**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:
The main aim of this course is to make students understand different types of environment influencing business decisions and to provide knowledge about different laws that needs to be followed for initiating and managing business.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO BUSINESS** Scope and Characteristics of Business, Classification of Business Activities Forms of Ownership of Business: Sole Proprietorship, Partnership and Company	**5**
2	**BUSINESS ENVIRONMENT** Internal Environment: Concept and Elements (Value System, Vision Mission Objectives, Management Structure, Human Resources, Company Image etc.) SWOT Analysis: Concept and Case Study External Environment: Micro Environment (Suppliers, Customers, Competitors, Market Intermediaries etc.) and Macro Environment – PESTEL Analysis (Political, Economic, Social, Technological, Ecological and Legal), Case Study on Impact of Environment on Business	**7**
3	**GLOBALIZATION** Concept, Pros and Cons of Globalization, Impact of Global Environment on Business Globalization of Company – Case Study	**4**
4	**CORPORATE SOCIAL RESPONSIBILITY** Concept, Social Responsibility towards different stakeholders, Rationale for CSR CSR – Case Studies	**2**
5	**CORPORATE GOVERNANCE** Concept, Elements and Essentials of Good Governance	**3**
6	**CONTRACT LAW** Concept, Types and Essentials Elements of Contract	**3**
7	**PARTNERSHIP LAW** Nature of Partnership, Provisions of Partnership Act, Issues Related to Partnership Firm, Hypothetical Formation of a Partnership Firm	**2**
8	**COMPANY LAW** Nature of Company, Provisions of Company Act, Issues Related to Incorporation of Company, Hypothetical Formation of a Company	**2**

Course Outcomes:	
1	The students will be able to analyze the impact of environment on business and formulate appropriate business strategies to compete in the competitive world.
2	The students will learn how companies follow corporate governance and social responsibility practices along with fulfilling economic objectives.
3	The students will gain knowledge about application and implementation of various business laws in practice.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**

1	"Business Environment: Text and Cases", Cherunilam F., 22nd Edition, Pubs: Himalaya Publications.	2013
2	"Legal Aspects of Business", Pathak A., 5th Edition, Pubs: McGraw Hill Education.	2013
3	"Essential of Business Environment: Text, Cases and Exercises", Aswathappa K., 11th Edition, Pubs: Himalaya Publication.	2011
4	"Business Law Including Company Law", Gulshan S.S. and Kapoor G.K., 15th Edition, Pubs: New Age International (p) Ltd.	2011
5	"Business Law and Corporate Laws", Tulsian P.C., 1st Edition, Pubs: Sultan Chand Publishing.	2011
6	"Fundamentals of Business Organization & Management", Bhushan Y.K., 19th Edition, Pubs: Sultan Chand & Sons.	2013
7	"Corporate Governance: Principles, Policies and Practices", Fernando A.C., 2nd Edition, Pubs: Pearson India.	2011

Course Name	**:**	**ENTREPRENEURSHIP AND PROJECT MANAGEMENT**
Course Code	**:**	**HSM 403**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:
The main aim of this course is to make prospective engineers familiar with the concept of entrepreneurship and MSMEs and to provide knowledge about different aspects to be considered while formulating the business plan for a new entrepreneurial venture. This course also intends to create awareness among students about financial and marketing functions that is required for a new venture.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO ENTREPRENEURSHIP** Concept of Entrepreneurship, Characteristics and Functions of Entrepreneur Forms of Ownership of Business, Factors Affecting Entrepreneurship Case Studies of Entrepreneurs	**6**
2	**WOMEN ENTREPRENEURSHIP** Nature of Women Entrepreneurship, Problems of Women Entrepreneurs, Institutional Initiatives for Promotion of Women Entrepreneurs	**2**
3	**MICRO, SMALL AND MEDIUM ENTERPRISES (MSMES)** Concept of MSMEs, Schemes of MSMEs	**2**

	Functions of Entrepreneurial Development Programmes (EDPs)	
4	**PROJECT IDENTIFICATION** Idea Generation, Project Life Cycle, Concept of SWOT Analysis SWOT Analysis of Selected Project	**2**
5	**PROJECT PLANNING AND FORMULATION** Elements of Project Formulation: Product, Technical (Location, Scale, Technology, Production Process, Layout, Manpower, Resources etc.), Market, Finance and Economic Aspects Feasibility Analysis: Financial Viability and Profitability, and Socio-Economic Desirability	**7**
6	**PROJECT REPORT** Formulation of Business Plan and Project Report, Hypothetical Example of a Real-Life Project	**2**
7	**FINANCE AND MARKETING FUNCTION** Concept of Finance, Finance Related Terminologies, Sources of Finance, Cost Estimations Marketing Mix: Product, Place, Price, Promotion, People, Process and Physical Evidence Marketing Segmentation Targeting and Positioning	**5**
8	**DISCUSSIONS ON ADDITIONAL READING** (any one of the following in the semester) - The New Age Entrepreneurs - The $100 Startup: Fire your Boss, Do what you Love and Work Better to Live More - A Guide to Entrepreneurship - Dhandha: How Gujaratis Do Business - Rokda: How Baniyas Do Business - Take Me Home - Business Families of Ludhiana	**2**

Course Outcomes:	
1	The students will be able to apply engineering knowledge effectively in the field of entrepreneurship development.
2	The students can make effective use of entrepreneurial knowledge to start and manage their venture.
3	The students will learn to check the feasibility of a new project to maintain its long run sustainability.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Dynamics of Entrepreneurial Development & Management", Desai V., 5th Edition, Pubs: Himalaya Publishing House.	
2	"Projects: Planning, Analysis, Selection, Financing, Implementation and Review", Chandra P., 8th Edition, Pubs: McGraw-Hill Education (India).	2014
3	"Entrepreneur's Toolkit", Harvard Business School, Pubs: Harvard University Press.	2004
4	"Entrepreneurship", Hisrich R.D., Peters M.P. and Shepherd D.A., Pubs: McGraw Hill Education.	2006
5	"Essentials of Project Management", Ramakrishna K, Pubs: PHI Learning.	
6	"Entrepreneurship", Roy R., 2nd Edition, Pubs: Oxford University Press	2011
7	"Entrepreneurship Development in India", Gupta C.B. and Srinivasan N.P., Pubs: Sultan Chand and Sons.	2013

Course Name	**:**	**FINANCIAL MANAGEMENT**
Course Code	**:**	**HSM 404**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:
The main aim of this course is to make students learn different financial decisions i.e. investing, financing and dividend, required to be taken by a company and provide knowledge about the functioning of the financial system (financial markets, financial institutions, financial services and financial instruments) of the country.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO FINANCIAL MANAGEMENT** Concept of Finance, Terminology Related to Finance, Financial Decisions, Factors Affecting Financial Decisions, Risk-Return Trade-Off	**3**
2	**FINANCIAL SYSTEM** Concept and Role of Financial System in Indian Economy	**2**
3	**FINANCIAL MARKETS AND INSTRUMENTS** Concept and Relevance of Money Market and Capital Market Money Market Instruments: Call Money, Treasury Bills, Commercial Papers, Certificate of Deposits Capital Market Instruments: Equity Shares, Preference Shares and Debentures Hypothetical Trading in Financial Markets	**5**
4	**FINANCIAL SERVICES** Nature and Functions of Financial Services: Merchant Banking, Mutual Funds, Factoring, Forfaiting, Credit Rating Case Study on Financial Services	**6**
5	**FINANCIAL INSTITUTIONS** Nature and Functions of Financial Institutions: Reserve Bank of India (RBI), Securities and Exchange Board of India (SEBI), Discount and Finance House of India (DFHI)	**2**
6	**LONG TERM INVESTMENT DECISIONS** Capital Budgeting: Concept, Importance, Factors Techniques/Methods with Numerical Applications (Pay Back Period, Accounting Rate of Return, Net Present Value, Internal Rate of Return and Profitability Index), Case Study	**3**
7	**SHORT TERM INVESTMENT DECISIONS** Working Capital: Nature, Type and Factors Affecting the Requirement of Working Capital, Case Study	**2**
8	**FINANCING DECISIONS** Capital Structure: Essentials and Approaches of Capital Structure Sources of Finance (long-term and short-term), Financial Leverage: Concept and Numerical Application, Case Study	**3**
9	**DIVIDEND DECISIONS** Types of Dividend, Dividend Policy: Nature and Factors Affecting Dividend Policy, Case Study	**2**

Course Outcomes:	
1	The students will learn to make best combination of financial decisions by considering risk and return trade-off.
2	The students will identify how business can gain maximum through the financial system.
3	The students will understand how to manage funds effectively so as to maximize returns.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Financial Management", Shah P., 2nd Edition, Pubs: Dreamtech Press	2009
2	"Financial Markets and Services", Gordon E. and Natarajan K., 3rd Edition, Pubs: Himalaya Publishing House.	2006
3	"Financial Management: Theory and Practice", Chandra P., 8th Edition, Pubs: McGraw Hill Education (India).	2012
4	"Financial Management", Pandey I.M., 10th Edition, Pubs: Vikas Publishing House Pvt. Ltd., Noida.	2010
5	"Cases in Financial Management", Pandey I.M. and Bhat R., 3rd Edition, Pubs: McGraw Hill Education (India).	2012
6	"Financial Institutions and Markets: Structure, Growth and Innovations", Bhole L.M. and Mahakud J., 5th Edition, Pubs: McGraw Hill Education (India).	2009
7	"The Indian Financial System: Markets, Institutions and Services", Pathak B.V., 3rd Edition, Pubs: Pearson India.	2010
8	"Financial Management and Policy", Horne J.C.V. and Dhamija S., 12th Edition, Pubs: Pearson India.	2011

Course Name	**:**	**MARKETING MANAGEMENT**
Course Code	**:**	**HSM 405**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:
The main aim of this course is to make students understand about the marketing concepts to be applied in real life and the marketing process for delivering value to customers.

Total No. of Lectures –28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO MARKETING** Concepts, Role, Scope and Types of Marketing, Case Study on Marketing Management	**3**
2	**MARKETING RESEARCH** Scope and Process of Marketing Research, Hypothetical Marketing Research Analysis	**3**
3	**CONSUMER AND BUSINESS MARKETS** Types of Markets, Building Customer Value Consumer and Business Buying Behaviour: Factors Influencing Behaviour and Buying Decision Process	**4**

4	**SELECTION OF MARKETS** Segmentation: Factors and Bases, Targeting and Positioning Preparation of STP of Selected Product	**3**
5	**MARKETING MIX** 7 P's of Marketing Mix: Product, Price, Physical Distribution, Promotion, People, Process and Physical Evidence Formulation of Marketing Mix of Selected Product	**3**
6	**PRODUCT DECISIONS** Product (Good or Service) Characteristics, Product Life-Cycle, Packaging and Branding, Product Development and Management	**3**
7	**PRICING DECISIONS** Pricing Policies and Strategies, Factors Influencing Pricing	**3**
8	**PHYSICAL DISTRIBUTION DECISIONS** Marketing Channels, Channel Players, Physical Distribution, Managing Distribution, Analysis of Supply Chain Management – Case Studies	**3**
9	**PROMOTION DECISIONS** Nature of Promotion Decisions, Managing Mass Communication and Personal Communication Analysis of Promotional Strategies – Case Studies	**3**

Course Outcomes:	
1	The students will learn how to market goods and services effectively to different segments so as to deliver value to customers.
2	The students will be able to formulate marketing mix and marketing strategies for different products and different sets of customers.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Marketing Management: Concepts, Cases, Challenges and Trends", Govindarajan M, 2nd Edition, Pubs: PHI Learning.	2009
2	"Marketing Management", Kotler P., Keller K.L., Koshy A. and Jha M., 14th Edition, Pubs: Pearson India.	2012
3	"Marketing Concepts and Strategies", Dibb S., Simkin L., Pride W.M. and Ferrell O.C., Pubs: Cengage Learning.	2012
4	"Marketing Management", Kumar A. and Meenakshi N., 2nd Edition, Pubs: Vikas Publishing House Pvt. Ltd., Noida.	2011
5	"Marketing Management", Saxena R., 4th Edition, Pubs: McGraw Hill Education (India).	2013
6	"Marketing: Managerial Introduction", Gandhi J.C., 1st Edition, Pubs: McGraw Hill Education.	1987
7	"Marketing", Etzel M.J., Walker B.J., Stanton W.J. and Pandit A., 14th Edition, Pubs: McGraw Hill Education (India).	2010

8	"Super Marketwala: Secrets to Winning Consumer India", Mall D., 1st Edition, Pubs: Random House India.	2014

Course Name	**:**	**HUMAN RESOURCE MANAGEMENT**
Course Code	**:**	**HSM 406**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objectives:
The main aim of this course is to provide an overview of HRM, keeping the Indian business scenario in the background and to acquaint the students with the strategic role of HRM in managing an organization.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO HUMAN RESOURCE MANAGEMENT** HRM: Nature, Scope, Functions, HRM Practices and Problems in India with Case Studies	**4**
2	**HUMAN RESOURCE PLANNING (HRP)** Concept and Process of HRP, Factors Affecting HRP	**3**
3	**JOB ANALYSIS AND DESIGNING** Uses and Process of Job Analysis, Job Description and Job Specification: Features and Hypothetical Formulation, Job Designing: Job Enrichment, Job Enlargement	**3**
4	**RECRUITMENT AND SELECTION** Recruitment: Sources and Methods Selection: Selection Process, Selection Tests, Types and Nature of Interviews Role Playing and Case Study on Selection Process, Tests and Interview	**4**
5	**INDUCTION AND INTERNAL MOBILITY** Induction Programme, Need and Scope of Internal Mobility: Transfer, Promotion, Demotion	**3**
6	**TRAINING AND DEVELOPMENT** Training: Need and Methods, Management Development: Need, Methods and Management Development Programme HRM Games for Development of Employees	**4**
7	**PERFORMANCE APPRAISAL AND COMPENSATION** Nature and Methods of Performance Appraisal, Hypothetical Performance Appraisal Compensation: Financial and Non-Financial Benefits	**4**
8	**EMPLOYEE HEALTH AND SAFETY** Concept, Issues related to Health and Safety, Workplace Health Hazards	**3**

Course Outcomes:	
1	The students will develop the ability to solve problems in area of HRM in organizations.
2	The students will become aware of latest developments in HRM practices which are essential for effective management in organization.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Human Resource Management: Text and Cases", Rao V.S.P., Pubs: Excel Books.	2002
2	"Human Resource Management", Dessler G. and Varkkey B., 12th Edition, Pubs: Pearson	2011

	India.	
3	"Human Resource Management: Text and Cases", Aswathappa K., 7th Edition, Pubs: McGraw Hill Education (India).	2013
4	"Human Resource Management: Text and Cases", Gupta C.B., 14th Edition, Pubs: Sultan Chand and Sons.	2012
5	"Human Resource Management: Text and Cases", Bedi S.P.S. and Ghai R.K., Pubs: Bharti Publications.	2012
6	"Human Resource Management Applications: Cases, Exercises, Incidents and Skill Builders", Fottler M.D., McAfee R.B. and Nkomo S.M., 7th Edition, Pubs: Cengage Learning.	2013

ENGINEERING SCIENCE COURSES

Course Name	**:**	**COMPUTER PROGRAMMING (BASIC)**
Course Code	**:**	**CSN104**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
To develop logical skills so that students should be able to solve basic computing problems. To learn the syntax and usage of C programming constructs.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO PROGRAMMING** Evolution of languages: Machine languages, Assembly languages, High-level languages. Software requirements for programming: System softwares like operating system, compiler, linker, loader; Application programs like editor. Algorithm, specification of algorithm. Flowcharts.	4
2	**PROGRAMMING IN C** Data types in C, Formatted input-output for printing integer, floating point numbers, characters and strings.	2
3	**OPERATORS AND EXPRESSION** Expressions in C and their evaluation. Precedence and associativity rules. Operators: arithmetic operators, relational operators, logical operations, bitwise operators, miscellaneous operators.	6
4	**STATEMENTS** Decision making structures: if, if-else, nested if and if-else, switch. Control structures: for, while, do-while. Role of statements like break, continue, goto.	6
5	**ARRAYS** Concept and use of arrays, declaration and usage of arrays, 2-dimensional arrays.	6
6	**FUNCTIONS** Advantage of modularizing C program into functions, function definition and function invocation. Methods of passing parameters to a function: call-by-value, call-by-reference; Passing arrays to functions, Recursion, Library functions.	4
7	**POINTERS** Pointer declaration and initialization, constant pointers, pointers to constant objects, pointer arithmetic, relationship between pointer and arrays.	4
8	**SCOPE AND LIFETIMES** Scope and lifetime of a variable, storage classes: auto and typedef.	2
	USER-DEFINED DATA TYPES Structures- definition, declaration, use, accessing structure members directly or through pointer structure, structure having arrays and pointers as members, self referential structures, passing structures to functions. Unions: definition, declaration, use, accessing union members directly or through pointer structure.	6
	FILES Concepts of files and basic file operations.	2

Course Outcomes:	
1	The student will demonstrate proficiency in C programming language.

Text Books:	
1	Let Us C, Yashwant Kanetkar, BPB Publications
2	Programming in C: A practical approach, Ajay Mittal, Pearson Education

Reference Books:

1	The C programming language, Kernighan Ritchie, Pearson Education
2	Programming in ANSI C, Balaguruswamy, Tata McRaw Hill
3	Computing Fundamentals, Peter Nortan, Tata McRaw Hill

Course Name	**:**	**COMPUTER PROGRAMMING (ADVANCED)**
Course Code	**:**	**CSN105**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:
To develop logical skills so that students should be able to solve basic computing problems. To learn the syntax and usage of C programming constructs at advanced level.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO STRUCTURED PROGRAMMING** Introduction to topics: decision making, Iteration, functions: functions with variable number of arguments, multiple file programs, concept of linking.	6
2	**ARRAYS** Array declaration and use, Two-dimensional arrays and multi-dimensional arrays. Strings and Character arrays. Operations on arrays such as insertion, searching, sorting, merging.	6
3	**POINTERS** Pointer expression, pointer arithmetic, pointer to array, pointer to functions, dynamic memory allocation, dynamic allocation of arrays. Call functions through function pointers, Accessing members of arrays through pointers.	6
4	**PREPROCESSOR DIRECTIVES** Introduction, Various preprocessor directives, macros with and without arguments, conditional compilation.	6
5	**STRUCTURE, UNION, ENUMERATION AND BIT-FIELDS** Definition, declaration and initialization, structures containing arrays, array of structures, structure having structures, pointers to structures, self-referential structures, dynamic allocation of structures; Unions: Definition, declaration and initialization. Concepts of interrupts interrupt programming, enumerations and bit-fields.	8
6	**FILES** Concept of file, file operations, text mode and binary mode, command line arguments.	4
7	**INTRODUCTION TO OBJECT ORIENTED PROGRAMMING** Classes and objects, basic features of object oriented programming like encapsulation, abstraction, polymorphism, etc.	3
8	**APPLICATIONS** Projects related to the development of Terminate and Stay resident (TSRs), graphical applications, text-editors, etc.	3

Course Outcomes:	
1	The student will demonstrate proficiency in C programming language.

Text Books:	
1	Let Us C, Yashwant Kanetkar, BPB Publications
2	Programming in C: A practical approach, Ajay Mittal, Pearson Education

Reference Books:	
1	The C programming language, Kernighan Ritchie, Pearson Education
2	Programming in ANSI C, Balaguruswamy, Tata McRaw Hill

3	Computing Fundamentals, Peter Nortan, Tata McRaw Hill

Course Name	**:**	**ENGINEERING DRAWING**
Course Code	**:**	**ESC 101**
Credits	**:**	**4**
L T P	**:**	**2-0 -4**

Course Objectives:
At the end of this course, the student should be able to understand the basic concepts of Engineering Drawing. The student should be able to visualize and draw the two and three dimensional objects. The student should also be able to apply drafting softwares in various types of problems.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	Introduction to Engg. Graphics, System of Projections, Orthographic projections, Lettering, Dimensioning rules	2
2	Projections of points and lines, Projection of lines on different planes, Traces and true length of the lines	2
3	Projections of planes/laminae on reference planes, classification of Primary and secondary planes, examples	2
4	Classification of solids, Projections of solids on the basis of positions of the axis of various solids on reference planes	3
5	Sectioning of solids, True and apparent sections, sectioning on the basis of position of section planes	3
6	Developments of surfaces, Parallel line, Radial line and Triangulation methods of development of right and oblique solids	3
7	General introduction to Perspective projection, isometric views, Isometric lines & Axes, Four centre and off set method of drawing ellipse from circle, conversion of orthographic views to isometric views and vise-versa	3
8	Introduction to AutoCAD software for drawing of 2D projections, practical exercises on points, lines, planes and solids	10

List of Experiments:		**Number of Turns**
1	Exercises on projection of Points on drawing sheets	1
2	Exercises on projection of lines on drawing sheets	1
3	Exercises on projection of planes on drawing sheets	1
4	Exercises on projection of solids on drawing sheets	2
5	Exercises on sections of solids on drawing sheets	1
6	Exercises on Developments of surfaces and Isometric projections on drawing sheets	2
7	Practice of exercises on points and lines using AutoCAD software	1
8	Practice of exercises on planes using AutoCAD software	2
9	Practice of exercises on solids and developments using AutoCAD software	2
10	Practice of exercises on isometric projections using AutoCAD software	1

Course Outcomes: At the end of this course, the students will be able to:	
1	Understand the basic concepts of Engineering Graphics.
2	Visualize the actual objects and convert them in to readable drawings.
3	Understand the drawing standards, conventions and symbols that are in common usage.
4	Draw the common Engineering drawings using available drafting softwares.
5	Come up with innovative conceptual ideas by using Drafting softwares.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Engineering Drawing", P. S. Gill, S.K. Kataria & Sons	2012
2	"Engineering Drawing", D.A. Jolhe, Tata McGraw Hill	2010
3	"Engineering Graphics with Auto CAD", James Bethune, Prentice Hall, India	2003

Course Name	**:**	**FLUID MECHANICS**	
Course Code	**:**	**ESC102**	
Credits	**:**	**4**	
L T P	**:**	**3 0 2**	

Course Objectives:
To learn the basic concept of fluid mechanics. To understand the analytical method of solving fluid mechanics problem

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Fluids, Brief history of Fluid Mechanics, Properties of Fluid, Viscosity, Capillarity, Surface Tension, Compressibility, Normal and Shear Stresses in Fluid Flows, Regimes of Flow	4
2	**FLUID STATICS** Pascal's Law of measurement of pressure, Types of forces on a fluid system, manometers and gauges, forces on partially and fully submerged bodies including that on curved surfaces, Buoyancy, stability of floating bodies, centre of gravity, Metacentric height.	**6**
3	**KINEMATICS OF FLUID FLOW** Langrangian and Eulerian methods, description of properties in a moving fluid, local and convective acceleration, Streamlines, Path lines, Streak lines, Laplace equation, Stream function, velocity potential and flownets.	**4**
4	**DYNAMICS OF FLUID FLOW** Equation of conservation of mass, differential form of continuity equation. External forces, Euler's equation of motion, Bernoulli's equation, simple application to one dimensional flow, linear momentum and angular momentum, momentum theorem, moment of momentum theorem	**8**
5	**VISCOUS FLOW** Pressure gradient in steady uniform flow, flow between parallel plates, Qualitative aspects of viscous flows, Hagen-Poiseulli's flow, Transition from laminar to turbulent flow, turbulent flow in circular pipe, Navier Stokes equation (without derivation).	**5**
6	**FLOW THROUGH PIPES** Introduction, energy and hydraulics grade line, non-dimensional formulation of the pipe flow problem, head losses in pipes & pipe fittings, pipe in series & parallel, reservoir problem.	**5**
7	**DIMENSIONAL ANALYSIS AND SIMILITUDE** Buckingham's Theorem, non-dimensional groups, Geometric, Kinematic and Dynamic Similarity, Hydraulic Models.	**4**
8	**FLOW MEASUREMENT** Venturimeter, orifice meter, Pitot tube, Orifices, mouth pieces, notches, weirs, Current meter.	**6**

List of Experiments:

1	Flow Measurement by Orifice Meter
2	Flow Measurement by Venturimeter
3	Flow Measurement by V Notche
4	Computation of various coefficients involving in through orifice.
5	Determination of friction factors of pipes Minor losses in pipes
6	Determination of friction factors of pipes
7	Verification of Bernoulli's theorem
8	To determination of the metacentric height of a given vessel under unloaded condition.

Course Outcomes:	
1	To apply the learned techniques in real life problems related to fluid mechanics.

Text Books:	
1	G.L. Asawa, "Experimental Fluid Mechanics-Volume I" Nem Chand & Brothers
2	B. S. Kapoor, "Manual of Fluid Mechanics" Khanna Publishers
3	S. Singh, "Experiments in Fluid Mechanics-Second Edition" PHI Publications

Reference Books:	
1	Frank M. White, "Fluid Mechanics", McGraw Hill.
2	H. Rouse , "Elementary Mechanics of Fluids"
3	Streeter, V.L.,"Fluid Mechanics" McGraw Hill Co
4	Lewitt, E.H.,"Hydraulics and the Mechanics of Fluids" Pitman

Course Name	**:**	**INTRODUCTION TO MANUFACTURING**
Course Code	**:**	**ESC 103**
Credits	**:**	**4**
L T P	**:**	**2-0-4**

Course Objectives:
At the end of the course the students should be able to describe the properties of engineering materials and different manufacturing processes. The students should be able to select appropriate manufacturing process and manufacture a job in the different shops and areas of applications.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Classification of manufacturing processes, classification of engineering materials, comparison of material properties of metals, ceramics and plastics, crystal structures, strain hardening effects, stress-strain curves. Safety measures in workshop.	3
2	**MATERIALS AND HEAT TREATMENT** Objective of heat treatment, classification of heat treatment, annealing, normalizing, hardening & tempering, case hardening, carburizing, nitriding, flame hardening, induction hardening, applications of heat treatment.	4
3	**FOUNDRY** Pattern, properties of pattern material, types of pattern, cores. Types of sand, moulding sand ingredients. Types of moulding processes. Types of casting processes: sand casting, shell casting, investment casting and centrifugal casting. Casting defects & remedies. Case studies and applications.	4
4	**FORMING** Metal forming, types and applications, hot & cold working, forging, drawing, rolling and sheet metal operations.	3

5	**MACHINING** Metal removal processes, machines, single-point tool, cutting tool geometry, lathe - types, elements and main parts of lathe, drilling, milling and grinding machines. Applications.	3
6	**FINISHING** Surface finishing processes, principle and applications, lapping, honing, super finishing, polishing, buffing, electroplating, galvanizing.	2
7	**WELDING** Classification of welding processes, mechanism of arc formation, arc welding processes, gas welding, and resistance welding, principles and applications, welding defects, causes and remedies. Soldering and brazing. Applications and case studies in welding.	3
8	**PLASTICS MANUFACTURING** Types and properties of plastics, thermosetting and thermoplastic resins, elastomers. Fabrications of plastics, injection moulding, blow moulding, extrusion moulding etc.	2
9	**MODERN MANUFACTURING PROCESSES** Introduction, classification, electric discharge machining (EDM), electro chemical machining (ECM), laser beam machining (LBM) and Rapid Prototyping Techniques. Case studies on modern and hybrid manufacturing processes.	2
10	**CASE STUDIES** Considerations of selecting manufacturing processes for industrial products like compact disc, PCB and emerging technological applications.	2

List of Experiments:		**Number of Turns**
1	To prepare half lap T & L joint in the carpentry shop.	1
2	To prepare the pattern of half nut in carpentry shop.	1
3	To prepare cube from a piece of round bar in forging shop.	1
4	To study the lathe, milling, planer, and shaper operations.	1
5	To manufacture a multi-operational job on lathe/milling in the machining shop.	1
6	To prepare series and parallel wiring connections in the electrical shops.	1
7	To prepare the butt joint by SMAW in welding shop.	1
8	To prepare the mould of a given pattern in foundry shop.	1
9	To cast the prepared mould in foundry shop.	1
10	To prepare a square job in the fitting shop.	1
11	To prepare rectangular box in sheet-metal shops.	1
12	To prepare different joints in the sheet-metal shop.	1

Course Outcomes: By the end of this course, the students will be able to:	
1	Compare the properties of the engineering materials.
2	Select the appropriate manufacturing process for a given job/ application.
3	Identify the advantages and limitations of different manufacturing processes.
4	
5	

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Manufacturing Engineering and Technology", Serope Kalpakjian and Steven Schmid, Pearson Publications.	2009
2	"A Textbook of Production Technology: Manufacturing Processes", P. C. Sharma, S. Chand & Company Ltd.	2004
3	"Foundry, Forming and Welding", P.N. Rao, Tata M/C Graw Hill Publication.	2007
4	DeGarmo, Materials and Processes In Manufacturing, John Wiley & Sons	2011

Course Name	**:**	**THERMODYNAMICS**
Course Code	**:**	**ESC 201**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student should be able to, Understand the basic principles of Thermodynamics and to give students a feel for how Thermodynamics is applied in Engineering practices.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**BASIC CONCEPTS :**Macroscopic and Microscopic Approach, Concept of Continuum, Thermodynamic System, Surrounding and Boundary, Thermodynamic Equilibrium, State, Path, Process, cycle, Quasi-static Process, Reversible and Irreversible Process, Working Substance. Thermodynamic Properties like Pressure, Volume and Temperature, Zeroth Law of Thermodynamics. Temperature Scales, Concept of Heat and work in Thermodynamics.	**8**
2	**FIRST LAW OF THERMODYNAMICS:** Joule's Paddle wheel Experiment; Mechanical Equivalent of Heat, First Law for a closed system undergoing a Cycle, First Law for a closed system undergoing a change of state. Different forms of stored Energy, Enthalpy, Energy of An isolated System, Perpetual Motion Machine of First kind.	**6**
3	**FIRST LAW APPLIED TO FLOW PROCESSES:** Flow Process and Control Volume, flow work, Steady and Unsteady Flow Process, Steady Flow Energy Equation, Engineering Applications of Steady Flow Energy Equation, Throttling Process, Flow Work and Non Flow work, Variable flow Processes, Limitation of First Law.	**5**
4	**SECOND and THIRD LAW OF THERMODYNAMICS:** Qualitative Difference between Heat and Work, Thermal Reservoir, Statements of 2nd Law by Max.Planck and Claussius, Equivalence between two statements, Energy Analysis of Heat Engine, Refrigerator and Heat Pump Reversibility and Irreversibility, Causes of Irreversibility Carnot Theorem, Carnot cycle, Absolute Thermodynamic Temperature, Scale, Efficiency of the Reversible Heat Engine, Equality of Ideal Gas Temperature and Kelvin Temperature.	**8**
5	**ENTROPY**: Classius Theorem, Classius Inequality and concept of Entropy, Entropy change in an Irreversible Process, Application of Entropy Principle, Entropy Transfer with Heat Flow, Entropy generation in closed and open System, Thermodynamics Equations relating properties of System, Reversible Adiabatic work in a Steady flow System. Entropy and direction, Entropy and disorder.	**5**
6	**PROPERTIES OF GASES AND GAS MIXTURE** : Equation of state of a gas, Properties of Mixture of gases, Internal Energy, Enthalpy and Specific heat of gas, mixtures, Entropy of gas Mixtures.	**3**
7	**STEAM GENERATORS:** Classification of steam generators, Boiler mountings and accessories. Principles and operations of steam accumulators. Description of Cochran, Locomotive, Lancashire, Babcock and Wilcox boiler, Modern high pressure boilers, Characteristics and advantages of high pressure boilers.	**7**
8	**BASIC CONCEPTS :**Macroscopic and Microscopic Approach, Concept of Continuum, Thermodynamic System, Surrounding and Boundary, Thermodynamic Equilibrium, State, Path, Process, cycle, Quasi-static Process, Reversible and Irreversible Process, Working Substance. Thermodynamic Properties like Pressure, Volume and Temperature, Zeroth Law of Thermodynamics. Temperature Scales, Concept of Heat and work in Thermodynamics.	**8**
9	**FIRST LAW OF THERMODYNAMICS:** Joule's Paddle wheel Experiment; Mechanical Equivalent of Heat, First Law for a closed system undergoing a Cycle, First Law for a closed system undergoing a change of state. Different forms of stored Energy, Enthalpy, Energy of An isolated System, Perpetual Motion Machine of First kind.	**6**

Course Outcomes:	
1	A fundamental understanding of various Laws of thermodynamics and their applications.
2	Understand the efficiencies of Heat Engines and other Engineering Devices.
3	Understand the working principles and applications of various types of steam generators.

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Engineering Thermodynamics", Gordon Rogers & Yon Machew	2006
2	"Thermodynamics", Yunus Cengel and Mike Boles	2006
3	"Thermodynamics", Arora.	2005
4	"Engineering Thermodynamics", P.K. Nag	2010
5	"Thermo dynamics", Dr. D.S. Kumar	2012

Course Name	**:**	**ESSENTIALS OF INFORMATION TECHNOLOGY**
Course Code	**:**	**ESC202**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The students should be able to understand the concepts of networking, RBMS, Software Engineering and Web Technology.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**NETWORKING AND COMMUNICATION** Introduction to digital communication: Signal propagation, signal types, signal parameters, Channel effect on transmission. Physical layer characterization: Types of transmission media, physical layer interfaces. Data transmission mechanisms: Communication modes, transmission modes, synchronization, introduction to packet switching, multiplexing, error control methods. Network architectures: Introduction to computer networks, Network topologies, Types of networks: LAN, WAN, MAN, layered network model. Internet Protocols: Introduction, Transport layer protocols: TCP, UDP. Application layer protocols: DNS, SMTP, POP, IMAP. Practical aspects of networking.	**12**
2	**RELATIONAL DATABASE MANAGEMENT SYSTEM** RDBMS- data processing – the database technology – data models- ER modeling concept – notations – converting ER diagram into relational schema - Logical database design - normalization (1NF, 2NF and 3NF). SQL – DDL statements – DML statements – DCL statements - Joins - Sub queries – Views - Database design Issues – SQL fine tuning.	**10**
3	**WEB TECHNOLOGIES AND INTRODUCTION TO USER INTERFACE AND WEB TECHNOLOGIES :** web fundamentals – types web content – HTML – text formatting tags in HTML – HTML form elements - and tags - text formatting using CSS : embedded CSS, inline CSS and external CSS – JavaScript and its features.	**10**
4	**SOFTWARE ENGINEERING** Software Engineering : Definition – role of software and software crisis – SDLC models : waterfall model, incremental model and spiral model – software testing – static & dynamic testing – types testing : unit testing, integration testing, system testing, performance testing and regression testing.	**10**

Course Outcomes:

1	Document artifacts using common quality standards
2	Design simple data store using RDBMS concepts

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Thomas Powell, HTML and CSS: The complete reference, 5th Edition	2010
2	Henry F Korth, Abraham Silberschatz, "Database system concepts", Second ed., McGraw-Hill International editions, Computer Science series	2006
3	A. Tanenbaum, Computer Networks, 5th Edition	2010
4	William Stallings, Data and Computer Communications, 10th Edition	2013

Course Name	**:**	**MATERIALS SCIENCE**
Course Code	**:**	**ESC 203**
Credits	**:**	**04**
L T P	**:**	**3 1 0**

Course Objectives:
The student will be able to know the concepts of atomic bonding, crystal structures, imperfections, diffusion, mechanical properties, electron energy, and dislocations as related to processing and performance of engineering material

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Historical perspective, Scope of Materials Science and engineering, Geometry of crystals, Structure determination by X-Ray Diffraction, Atomic structure and chemical bonding, Structure of solids	10
2	**IMPERFECTIONS IN ATOMIC AND IONIC ARRANGEMENTS** Point defects, Dislocations, Significance of Dislocations, Influence of Crystal structure, Surface defects, Importance of defects	4
3	**PHASE DIAGRAMS** Phase rule, Single component systems, Binary Phase diagrams, Microstructural changes during cooling, The lever rule, Some typical phase diagrams, Other applications of Phase diagrams	4
4	**DIFFUSION IN SOLIDS** Applications of Diffusion, Stability of atoms and ions, Mechanism for Diffusion, Activation energy for Diffusion, Rate of Diffusion (Fick's First Law), Factors affecting Diffusion, Composition Profile (Fick's Second Law), Diffusion and Materials Processing	4
5	**SOLIDIFICATION** Nucleation, Applications of Controlled Nucleation, Growth mechanisms, Solidification time and Dendrite size, Cast structure, Solidification defects, Solidification of Polymers and Inorganic glasses	4
6	**ELASTIC, ANELASTIC AND VISCOELASTIC BEHAVIOUR** Atomic model of elastic behaviour, The modulus as a parameter in design, Rubber-like elasticity, Relaxation processes, Spring-Dashpot model	4
7	**MECHANICAL BEHAVIOUR OF MATERIALS** Plastic deformations and creep in crystalline materials, Fracture	4
8	**ELECTRONIC AND MAGNETIC BEHAVIOUR OF MATERIALS** Conductivity of metals and alloys, Superconductivity, Semiconductors and their applications, Insulators and Dielectrics, Classification of magnetic materials, Magnetization,	4

	Permeability and magnetic field, Applications of magnetic materials	
9	**OVERVIEW OF MATERIALS** Metals, Ceramics, polymers and composites	4

Course Outcomes:	
1	The student will be able to develop structure-processing-properties co-relationsof materials.
2	The student will be able to describe various phenomena based on the concepts of solidification, Diffusion, mechanical behaviour of materials and compare characteristics of different types of materials such as metals, ceramics, polymers and composite

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Materials Science and Engineering-A First course/ V Raghavan/PHI	2013
2	Materials Science and Engineering, an Introduction/William D. Callister/ John Willey and Sons Inc. Singapore.	2007
3	Principles of Materials Science and Engineering/William Fortune Smith/TataMcGraw- Hill	1990
4	The Science and Engineering of Materials, Donald R Askeland&Pradeep P Phule/ Cengage Learning	2006

Course Name	**:**	**SOLID MECHANICS**
Course Code	**:**	**ESC 204**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course the student will be able to understand the basic concepts of behavior of the materials and analysis the basic structural elements like beams, columns, trusses and circular shafts. The student will be able to apply this knowledge for the design of various civil engineering structures.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**PROPERTIES OF MATERIALS** Introduction, uni-axial tension test, idealized stress- strain diagrams, isotropic, linear, elastic, visco-elastic and plastic materials, compression test, impact test, fatigue test, torsion and bending test.	4
2	**SIMPLE STRESSES & STRAINS** Concept of stresses and strains, relationship between elastic constants, extension of uniform bar & tapered bar under its own weight and due to load applied, stresses produced in compound bars due to axial loads, thermal stresses,	4
3	**COMPOUND STRESSES:** General state of stress, resultant stress and strain circle, prinicipal stresses and principal strains, Mohercircle for compound stresses and strais	4
4	**SHEAR FORCE AND BENDING MOMENT IN BEAMS** Shear force, bending moment, Relation between load, SF and BM, SFD , BMD and axial force diagram for determinate beams under various types of loading.	6
5	**BENDING AND SHEAR STRESSES IN BEAMS** Pure bending ,bending stresses, eccentric loading combined bending and direct stresses , Middle Third rule, composite beams, Variation of shear stresses for various cross-sections of a beam.	5

6	**ANALYSIS OF PLANE TRUSSES** Different types of trusses, Analysis of plane trusses by method of joints and method of sections.	5
7	**TORSION** Torsion equation for circular shaft , shafts under action of varying torque, torsion of composite shafts.	4
8	**COLUMNS & STRUTS** Criteria for stability of columns, Buckling of columns, Euler's theory for various end restraints, Rankine's formula, eccentrically loaded struts, struts with initial curvature, struts with lateral loading.	5
9	**DEFLECTION OF BEAMS** Slope and Deflection in beams by double integration method, Macaulay's method, Moment area method under the action of various loading conditions; slope and deflection in built in and propped beams.	5

Course Outcomes: By the end of this course the student will be able to:	
1	Analysis the simple civil engineering structures under different loading conditions.
2	Understand the behaviour of basic structural elements.
3	Apply this knowledge for the design of various civil engineering structures.
4	
5	

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"An introduction to the Mechanics of Solids", Crandall & Dahi, McGrawHill.	1978
2	"Strength of Material", G.H. Ryder, MacMillan.	2002
3	"Mechanics of Solids", E.P. Popov, Pearson Education.	1978
4	"Mechanics of Materials", E.J. Hearn, Elsevier Publications.	2001
5	"Mechanics of Materials", Punmia and Jain, Laxmi Publications (P) Ltd.	2013
6	"Mechanics of Materials", R.C.Hibbeler, Pearson Higher education.	2013
7	"Strength of Materials", S. Ramammurtham and R. Narayanan, Dhanpat Rai Publishing Comp	2014

Course Name	**:**	**INTRODUCTION TO ELECTRONICS**
Course Code	**:**	**ESC 205**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:

At the end of this course, the student should be able to

1. Identify active and passive components and to solve simple electronic circuits.
2. Explain the fundamental concepts of basic semiconductor devices & digital electronics.
3. Describe the basic principle of operational amplifier along with its applications, A/D, D/A conversion and architecture of 8085 microprocessor.
4. Define the communication system and list the various modulation techniques.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO ELECTRONICS:** Need and application of electronics in different areas, Basic elements of electronic system (Active and Passive elements, Sources,	3

	Dependent Sources), KVL and KCL	
2	**SEMICONDUCTOR DEVICES:** Concept of active and passive devices, Semiconductor Devices: Structure, principle of operation, characteristics and applications of PN-Junction (Rectifier, Clipper and Clamper), BJT, Current Components in BJT, Input & Output characteristics Common Emitter (CE), Common Base (CB), Common Collector (CC) configurations, BJT as an amplifier, Construction, working principle and characteristics of FET and MOSFET, Concept of feedback amplifier, Barkhuasen criteria, Oscillators, 555 timer as multivibrator, Four layer devices- SCR, DIAC and TRIAC (Construction, operation and characteristics)	15
3	**DIGITAL PRINCIPLES:** Digital waveforms, digital logic, moving and storing digital information, digital operations, digital integrated circuits	3
4	**OPERATIONAL AMPLIFIER AND ITS APPLICATIONS:** Block diagram, characteristics, inverting and non inverting configurations, Opamp as summing amplifier, difference amplifier, integrator, differentiator	5
5	**A/D AND D/A CONVERTERS:** Basic principle and characteristics, Weighted resistor D/A converter, Binary ladder D/A converter, counter ramp type A/D Converter	4
6	**INTRODUCTION TO MICROPROCESSOR:** Pin diagram, Architecture of 8085 Microprocessor, Concept of Microcontroller and its applications	3
7	**COMMUNICATION SYSTEMS**: Introduction to communication system, communication time line, Various frequency bands used for communication, Block diagram of Analog and Digital communication, need of modulation, Analog modulation techniques (Amplitude and frequency), Digital modulation techniques (PCM,PWM,PPM, PAM, ASK,FSK,PSK, QAM), Introduction to advanced communication systems (Optical and wireless).	9

Course Outcomes: By the end of the course the students will be able to	
1	Identify the various electronic devices and predict their behavior in an electronic system.
2	Draw the architecture of Microprocessor.
3	Differentiate between various modulation techniques in a communication system and relate them to practical systems.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Electronics Devices & Circuit Theory, RL Boylestead & L Nashelsky (PHI)	2009
2	Digital principles & applications, Malvino Leach, TMH	2011
3	Microprocessor Architecture programming and Applications with 8085 by R Gaonkar, Penram International Publishing Pvt ltd.	2002
4	Circuits and Networks: Analysis and Synthesis, Sudhakar and ShyamMohan, TMH	2009
5	Electronic Communication Systems by G. Kennedy, Mc Graw Hill, 4th Edition	2008
6	Electronic Communications, 4th Edition, Roddy & Coolen.	2009

Course Name	**:**	**BASIC ELECTRICAL SCIENCES**
Course Code	**:**	**ESC 206**
Credits	**:**	**04**
L T P	**:**	**3- 0-2**

Course Objectives:

At the end of this course, the student should be able to acquire knowledge of analytical techniques to solve electrical circuits, basic electrical machines, and electrical measuring instruments.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**BASIC DEFINITIONS AND NETWORK THEOREMS** Basic definitions of voltage, current, power and energy. Nodes, branches, loops, mesh, Kirchhoff 's laws, nodal & mesh analysis. Circuit theorems: linearity, superposition, Norton, thevenin, max power transfer.	8
2	**AC CIRCUITS** Introduction, Generation of alternating voltage, sinusoidal waveform, phasor diagram, power relations in AC circuits, single phase AC circuits, Steady State Analysis: Nodal and Mesh analysis, Thevenin's, Norton's, Maximum Power Transfer theorems. AC Power Analysis: Instantaneous and average power, max average power transfer, RMS value, apparent power and power factor, complex power, conservation of AC power. THREE PHASE CIRCUITS**:** Phase sequence, Star and delta connection, Relation between line and phase voltages and currents in balanced systems, Analysis of balanced and Unbalanced three phase circuits, Measurement of active and reactive power.	10
3	**MAGNETICALLY COUPLED CIRCUITS** Mutual Inductance, Energy in a coupled circuit. Transformer : construction, equivalent circuit, voltage regulation, efficiency, OC and SC tests.	5
4	**DC MACHINES** Construction, emf and torque equations, circuit model, methods of excitation, characteristics of generators and motors, starting and speed control of dc motors, starters, losses, efficiency.	5
5	**AC MACHINES** Rotating magnetic field theory, three phase induction machines: General construction features, per phase equivalent circuit, approximate equivalent circuit, production of torque, slip, torque speed characteristics, no load and blocked rotor test to determine performance parameters, Starting: rotor rheostat starter, reduced voltage starting, star delta starting, centrifugal start. Synchronous motors: types, salient pole and cylindrical rotor, emf equation. Principle of operation of single phase induction motor, types and applications.	10
6	**BASIC MEASURING INSTRUMENTS** Introduction, Classification of instruments, essential features and operating principles, moving coil and moving iron instruments.	4

List of Experiments:		Number of Turns
1	Verification KCL and KVL	01
2	Verification of Ohm's Law	01
3	Verification of the principle of , superposition with ac and dc sources	01
4	Verification of Thevenin, and Nortan theorems.	01
5	Verification of maximum power transfer theorem in dc circuit.	01
6	To study resonance in series and parallel RLC circuits and plot various responses.	01
7	To verify the line voltage and phase voltage , and line current and phase current relationship in a star and delta three phase balanced circuit.	01
8	Measurement of active and reactive power in single-phase ac circuit.	01
9	To perform open and short circuit test on a 1-phase transformer and determine its equivalent circuit and efficiency	01
10	To study dc machine and determine open circuit characteristic.	02
11	To perform open circuit test and block rotor test on a 3 phase IM to draw equivalent circuit.	01
12	To perform load test on D.C. shunt motor.	01

Course Outcomes: By the end of this course, the student will be able to:	
1	Apply different techniques to solve electrical circuits.
2	Acquire the knowledge of electrical machines and electrical measuring instruments.
3	Design and conduct experiments, as well as analyze and interpret data.

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Fundamentals of Electric Circuits by Charles K Alexander and Matthew N O Sadiku, Mc Graw Hill Higher Education, 5th edition, ISBN 0073380571.	2012
2	Network Analysis & Synthesis by FF Kuo, Wiley International	1966
3	Electric Machinery and Transformers by Bhag S Guru & Huseyin R Hiziroglu, Oxford University Press, ISBN 0195138902.	1988
4	Semiconductor Physics and Devices: Basic Principles by Donald A Neamen, Irwin Professional Publishing, 3rd Revised edition, ISBN 0256242143	2006

Course Name	**:**	**MECHATRONICS**
Course Code	**:**	**ESC 207**
Credits	**:**	**04**
L T P	**:**	**3-1-0**

Course Objectives:

At the end of this course the student should be able to have basic knowledge of mechatronics and its interdisciplinary applications i.e. integration of Mechanical engineering with Electrical& Electronics Engineering and Computer Technology. He should be able to design and conduct experiments as well as to analyze and interpret data.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**INTRODUCTION TO MECHATRONICS** Understanding Mechatronics. Key Elements of Mechatronics, Components of Mechatronics ,Human Being and Mechatronic System, Conventional and Mechatronic Approach, Advantages of Mechatronic Systems. Definition of System, Classification of System, Mechanistic System, Mechatronic System Intelligence.	04
2	**SENSOR AND TRANSDUCERS: PRINCIPLES AND APPLICATIONS** Role of Sensors and transducers in Mechatronics System , selection of sensors based on performance characteristics, static and dynamic characteristics); calibration; types of sensors , resistive transducers, inductive ,capacitive ,optical , thermal Transducer and their applications ,Measurement of : linear , angular position, displacement, rotational speed, force, pressure, strain, flow rate, temperature etc..	08
3	**SIGNAL CONDITIONING DEVICES** Role of signal conditioning **Processes** and devices in mechatronics, passive elements (RLC), semiconductors devices (PN junction diodes, AC rectification, Zener diode, Power supplies, transistors, Transistor (common emitter characteristics, emitter, follower circuit, FET); thyristor, TRIAC,DIAC, operational amplifiers (inverting, unity gain, non-inverting, C/V and V/C amplifiers, differential amplifier, instrumentation amplifier).Filters types of filters. **SIGNAL CONVERTING DEVICES**: Digital to analog converter (DAC) and Analog to Digital Converter (ADC), multiplexer.	09
4	**DIGITAL ELECTRONICS** Boolean algebra; digital electronic gates; combination logic systems (simple gates, NAND and NOR gates, latches, positive and negative logic, tri-state logic); sequential logic systems (J-K flip-flop, registers and counter, timers and pulse circuits).	05
5	**MICROPROCESSORS , MICROCONTROLLERS AND PLC'S** Fundamentals of microprocessor , the 8085, concept of interfacing memory, input /output devices , fundamentals of Microcontroller, T he 8051, PLC Hardware, PLC Memory structure, application	07

6	**ACTUATORS** Role of actuators in mechatronics, types of actuators, electrical actuators Physical principles; solenoid-type devices; DC machines; AC machines; stepper motors .Drive Technology Applications: Linear motors; voice coil motors; electro-pneumatic and electro-hydraulic actuators. Mechanical actuators :Rotary to linear motion conversion; power transmission, Electromechanical System Applications, Coupling, gearing, belts, pulleys, bearings.	07
7	**CASE STUDIES** Washing Machines, auto focusing camera, pick and place robot.	02

List of Experiments:		**Number of Turns**
1	To study various types of Resistors, Inductors, Capacitors, Diodes, Transistors, LED.	01
2	To study CRO, Function generator, Power Supply.	01
3	To study various components of Induction Machine and Synchronous Machine	01
4	To study various components of DC Machines and Transformers.	01
5	To obtain output voltage waveforms of half wave and full wave uncontrolled rectifier with and without filter capacitor.	02
6	To design a voltage regulator using Zener Diode and analyze the performance of the regulator for various loads. Also compare the performance with a linear voltage regulator.	02
7	To verify truth-tables of various flip-flops (J-K, D, Toggle etc.)	01
8	To study the characteristics of LVDT using linear displacement trainer Kit & compare with ideal characteristics.	01
9	To measure the strain of the metal strip using strain gauge trainer kit & compare with ideal characteristics.	01
10	To measure the angular displacement of resistive & capacitive transducer using angular displacement trainer kit & compare with ideal characteristics.	01
11	To obtain the characteristics of RTD, Thermistor, thermocouple with hot and cold junction thermal trainer kit & compare with ideal characteristics.	01

Course Outcomes: By the end of this course, the student will be able to:	
1	Students were able to have basic knowledge of mechatronics and its interdisciplinary applications i.e. integration of Mechanical engineering with Electronics
2	Students were able to design and conduct experiments

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Mechatronics, fourth edition, by W Bolton. ISBN 978-81-317-3253-3	2013
2	Dan Necsulescu Mechatronics published by Pearson Education (Singapore) Pvt. Ltd., Indian Branch, 482 FIE, Patparganj, Delhi India.	2001
3	Book by H M T Limited, Mechatronics Tata McGraw Hill Publishing Company Limited, New Delhi.	1988
4	Mechatronics Principles, Concepts & Applications by Nitaigour P Mahalik published by TMH	2003

Course Name	**:**	**MECHANICAL ENGINEERING DRAWING**
Course Code	**:**	**ESC**
Credits	**:**	**4**
L T P	**:**	**2-0-4**

Course Objectives:

At the end of this course, the student should be able to visualize objects and their graphical representations, understand the various engineering drawing symbols, conventions and other requirements of assembly and dis-assembly of mechanical engineering parts and materials and should be able to draw clear and understandable production drawings.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO ENGINEERING GRAPHICS:** System of Projections. Technical lettering. Drawing conventions, Orthographic projections. 3-views. Projection of oblique areas. Circular features. Dimensioning, Rules of dimensioning.	3
2	**ISOMETRIC PROJECTIONS:** General introduction to Isometric Projections. Conversion from orthographic to isometric projections and vice-versa. Freehand sketching.	3
3	Projections of Points, Lines and Planes. Geometrical Constructions.	5
4	Projection of Solids, sectioning. Auxiliary planes and views.	3
5	**REQUIREMENTS OF MECHANICAL ENGINEERING DRAWINGS:** Conventional representation, Layout of drawing sheet, symbols of standard tolerances, machining symbols. Introduction and familiarization of the code IS:296.	3
6	**FASTENERS:** Temporary and Permanent fasteners. Various types of screw threads, nuts and bolts, screws, welding joints and riveted joints.	3
7	**INTRODUCTION TO AUTOCAD:** Basic commands and features, simple exercises of points, lines, planes and solids on AutoCAD.	3
8	**ASSEMBLY AND DIS-ASSEMBLY DRAWING EXERCISES ON SOME OF THE FOLLOWING USING DRAWING SHEETS AS WELL AS AUTOCAD:** Couplings, Clutches, Knuckle and cotter joints, Pipe and pipe fittings, IC engine parts, Machine tool parts, Bearings, Screw Jack, Drill press vice.	5

List of Experiments:		**Number of Turns**
1	Drawing exercises on lettering, dimensioning, points, lines and planes	3
2	Drawing exercises on solids, sectioning and auxiliary planes	3
3	Drawing exercises on isometric and orthographic projections	2
4	Introduction to AutoCAD, familiarization with basic commands and features	2
5	Simple exercises of points, lines, planes, solids and sectioning of solids on AutoCAD	2
6	Drawing of machine parts on AutoCAD	2

Course Outcomes: By the end of this course, student will be able to	
1	Have knowledge of drawing symbols, conventions and methods of graphical representations.
2	Understand various machine components, their working and functions.
3	Able to read and understand mechanical engineering drawings.
4	Have working knowledge of the drafting package AutoCAD.
5	Able to understand and draw mechanical engineering drawings on AutoCAD.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Engineering Drawing by R. K. Dhawan	2012
2	Machine Drawing by R. K. Dhawan	2012
3	Engineering Drawing by P. S. Gill	2013
4	Machine Drawing by P. S. Gill	2013
5	Fundamentals of Engineering Drawing by Luzadder and Duff	2009
6	Engineering Graphics with AutoCAD by James D. Bethune	2011

TECHNICAL COMMUNICATION

Course Name	**:**	**TECHNICAL COMMUNICATION**
Course Code	**:**	**XXX-205**
Credits	**:**	**2**
L T P	**:**	**0-0-3**

Course Objectives:
At the end of the course the students should be able to effectively communicate as per their professional requirements.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Need for Effective Communication, Overview of Technical and Professional communication	**3**
2	Listening Skills, Reading Skills, Writing Skills	**3**
3	Writing Letters, Official E-mails, Job Applications, Resumes, Cover Letters, Notes. Case Studies	**6**
4	Overview of Research Writing. Information Gathering; Using the Library and Internet Modes, Organizing and Presenting According to Audience and Purpose. Writing Research Proposals, Project Technical Report/ Dissertation/Theses Writing. Case Studies.	**12**
5	Presentation Skills, Interview Skills, Group Discussion skills, Case Studies.	**9**
6	Technology Based Communication- Use of Visuals and Audio to Communicate Effectively.	**3**
7	Ethics, Attitude and Team Communication	**3**
8	Social Media/ Online Communication, Public Speaking; Developing an Authorial Voice	**3**

Course Outcomes: By the end of this course the student will be able to	
1	Develop effective technical communication.
2	Write technical documents in a professional manner.
3	Present professional requirements in an effective manner

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Meenakshi Raman and Sangeeta Sharma, "Fundamentals of Technical Communication", Oxford University Press, India	2014
2	Barun K Mitra, "Effective Technical Communication- A Guide for Scientists and Engineers" ,Oxford University Press, India	2006
3	David f Beer and David McMurrey, " Guide to Writing as an Engineer" ,2nd ed., Wiley	2004
4	Diane Hacker, " Pocket Style Manual", Bedford/St martin's.	2003

Course Name	**:**	**OPERATIONS RESEARCH**
Course Code	**:**	**MAN 401**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course , the students should be able to describe the need of Operations Research, develop the ability to form Mathematical models of Optimization problems, identify and solve linear models of Optimization problems, apply and to describe the limitations of classical methods to solve non-linear models of Optimization problems, apply and to describe the limitations of The Transportation Model ,Decision theory, Queuing Model.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Development of Operations Research, Definition of Operations Research, Characteristics of Operations Research, Scientific method in Operations Research, Necessity of Operations Research in industry, Scope of Operations Research	6
2	Formulation of Linear Programming problem , Graphical Solution, Simplex Method, Unrestricted variables, Artificial variables, M-Method, Dual Phase method	12
3	Introduction to the Transportation model, Assumption in the Transportation Model, Definition of the Transportation Model, Matrix terminology, Formulation and solution of Transportation Model	6
4	Decision theory, Steps in Decision theory approach, Decision making environments, Decision making under conditions of certainty, Decision making under conditions of uncertainty, Decision making under conditions of risk, Maximum likelihood criterion	6
5	Queuing Model, Introduction, Application of Queuing Model, Elements of Queuing System, Operating characteristics of Queuing System, Waiting time and idle time costs.	6
6	Non – Linear Programming, Introduction , Local and Global optimum, Concave and Convex functions, Types of non-linear programming problems.	6

Course Outcomes: By the end of this course, the students will be able to :	
1	Form Mathematical model of Optimization problems
2	Distinguish between linear and non-linear models
3	Solve simple problems of The Transportation Model
4	Solve simple problems of Decision theory
5	Solve simple problems of Queuing Model

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Operations Research" , Ravindran , Phillips , and Solberg , 2nd edition, John Wiley & sons .	2000
2	"Engineering Optimization" , S S Rao , 3nd edition, New Age .	2000
3	"Operations Research", Kantiswarup, Gupta P.K. & Sultan Chand & Sons .	2007
4	"Operations Research", Sharma S.D., Kedarnath, Ramnath & Company .	1994
5	"Operations Research", Bronson R, Shaum's Outline Series .	1997

Course Name	**:**	**OPTIMIZATION TECHNIQUES**
Course Code	**:**	**MAN 402**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the student shoule be able to describe the need of Optimization Techniques , develop the ability to form mathematical model of optimization problems , identify and solve linear models of optimization problems , apply and to describe the limitations of classical methods to solve nonlinear models for optimization problems , apply and to describe the limitations of gradient based and direct iterative methods to solve nonlinear problems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**LINEAR PROGRAMMING** Formulation, Graphical solution, Simplex method , Relation between Graphical and Simplex method, Unrestricted variables, Artificial variables, M-Method and Dual Phase method	**(14)**
2	**OPTIMIZATION TECHNIQUES** **UNCONSTRAINED PROBLEMS -** (Single and multivariable optimization) Necessary and sufficient conditions for extreme points **CONSTRAINED PROBLEMS - (**multivariable optimization) Equality constraints , Jacobian and Lagrangean methods , Application of Jacobian method to linear problems	**(12)**
3	**NON-LINEAR PROGRAMMING PROBLEMS** Geometric Programming **UNCONSTRAINED ALGORITHMS –** Direct methods, Dichotomous and Golden search ; Univariate and Hooke and Jeeves search methods ; Gradient methods , Cauchy's steepest ascent method and Newton's method.	**(12)**
4	**PROGRAMMING TECHNIQUES** Separable programming ,Geometric Programming	**(4)**

Course Outcomes:	
1	Form mathematical model of optimization problems
2	Distinguish between linear and nonlinear models .
3	Solve simple problems using classical / iterative methods .

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Operations Research , Ravindran , Phillips , and Solberg, 2nd edition 2000 , John Wiley & sons .	2000
2	Operations Research by Hamady Taha, 8th edition	
3	Engineering Optimization , S S Rao , 3rd edition 2000 , New Age .	2000
4	Operations Research 9th Edition, Kantiswarup, Gupta P.K. & Sultan Chand & Sons .	
5	Operations Research 8th Edition, Sharma S.D., Kedarnath, Ramnath & Company .	
6	Operations Research 2nd Edition, Bronson R, Shaum's Outline Series .	
7	P. Sankara Iyer, "Operations Research", Tata McGraw-Hill, 2008.	2008
8	J K Sharma., "Operations Research Theory & Applications , 3e", Macmillan India Ltd, 2007	2007
9	P. K. Gupta and D. S. Hira, "Operations Research", S. Chand & co., 2007.	2007

Course Name	**:**	**ADVANCED PHYSICS**
Course Code	**:**	**PYN-401**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course the students should be able to describe and implement concepts and principles of Quantum Mechanics required for in depth understanding of Physical phenomena of materials in relation to applications in Engineering. The students should be able to solve numerical problems in Nuclear and Solid State physics.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Quantum theory of light, X-rays - production, spectrum & diffraction(Bragg's Law), photoelectric effect, compton effect, pair production, photons & gravity, black holes, de-Broglie hypothesis, particle diffraction, uncertainty principle and applications. Postulates of quantum mechanics, Schrodinger theory, time-dependent and time-independent Schrodinger equation, wave function, Born interpretation and normalization, expectation values.	10
2	Particle in a box (infinite well potential), finite potential step and barrier problems, tunneling, linear harmonic oscillator (one-dimensional). Hydrogen atom, radiative transitions and selection rules, electron spin, Stern-Gerlach experiment, Spin-orbit coupling, exclusion principle, symmetric and anti-symmetric wave functions. Alpha decay, Zeeman Effect, Correspondence Principle, Angular Momentum in Quantum Mechanics.	10
3	Natural radioactivity, successive radioactive transformations, radioactive equilibrium, radioactive series, radiometric dating. Nuclear force and its characteristics, Elementary description of shell model, explanation of magic numbers, liquid drop model and semi-empirical binding energy formula. Nuclear fission, fission products, mass and energy distribution of fission products, neutron emission and energy distribution of neutrons emitted in fission, theory of fission process, nuclear reactors - classification, neutron cycle in thermal reactors and four-factor formula for neutron reproduction, nuclear fission - controlled thermonuclear reactions. Artificial radioactivity and its application, Beta-decay (energy spectrum & discovery of neutrino), fusion reactions in stars.	10
4	Band theory of solids, Kronig-Penney Model (qualitative), conductors, insulators and semiconductors, p-type and n-type semiconductors, statistics of electrons and holes, Hall effect (for single as well as both type of charge carriers).	6
5	Occurrence of superconductivity, destruction of superconductivity, Meissner effect, type I and type II superconductors, heat capacity, isotope effect, thermodynamical considerations, London equations & penetration depth, coherence length, BCS theory (elementary description), applications of superconductors. High temperature superconductivity, Josephson junctions.	6

Course Outcomes: By the end of this course:	
1	Students will be able to solve numerical problems in Quantum Mechanics, Nuclear and Solid State Physics.
2	Students will be aware of latest developments in certain areas of Physics like condensed matter physics, superconductivity etc. which have important applications for societal needs.
3	Students will be able to correlate the various phenomena with quantum mechanical concepts.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Concepts of Modern Physics", Arthur Beiser, McGraw Hill Education (India) Pvt. Ltd., New Delhi.	2013
2	"Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles", Robert Eisberg and	2013

	Robert Resnick, Wiley India Pvt. Ltd., New Delhi	
3	"Introductary Nuclear Physics", Kenneth S Krane, Wiley India Pvt. Ltd., New Delhi	2014
4	"Modern Physics", J. Bernstein, P.M. Fishbane and S.G. Gasiorowicz, Pearson, Education India Pvt. Ltd., New Delhi	2009

Course Name	**:**	**CRYSTAL PHYSICS**
Course Code	**:**	**PYN-402**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
During this course students will understand basics of crystal structure and correlate the same with different material properties. They will be able to describe the concepts of lattice dynamics and crystal binding forces and correlate the same with thermal properties.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**CRYSTAL STRUCTURES** - Periodic array of atoms, Lattice, basis, primitive cell, two and three dimensional lattice types, miller indices, examples of crystal structures (NaCl, CsCl structures), Hexagonal closed packed, diamond, zinc sulfide structures, x-ray diffraction of crystal, Bragg's Law, reciprocal lattice, diffraction condition, Laue equation, structure factor, atomic form factor.	12
2	**CRYSTAL BINDING** - van der waals interaction, repulsive interaction, equilibrium lattice constant, cohesive energy, ionic crystals, covalent crystals, electrostatic energy, Madelung constant.	10
3	**PHONONS AND CRYSTAL VIBRATIONS** - monoatomic basis, first Brillouin zone, dispersion relation, two atoms per primitive basis, quantization of elastic waves, phonon momentum, inelastic scattering by phonon.	10
4	**THERMAL PROPERTIES** - phonon heat capacity, density of states, Einstein model, Debye model of heat capacity, inharmonic crystal interaction, thermal expansion. Thermal conductivity, Umklapp Processes.	10

Course Outcomes: By the end of the course	
1	Students will be able to solve the problems based on crystal structure and thermal properties of solids
2	Understand and apply the basic concepts of crystal binding and crystal vibrations in different phenomena.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Introduction to Solid State Physics", Charles Kittel, Wiley India Pvt. Ltd., New Delhi	2012
2	"Solid State Physics", S.O. Pillai, New Age International (P) Limited, New Delhi	2010
3	"Crystallography Applied to Solid State Physics", Verma and Srivastava, New Age International (P) Limited, New Delhi	2012

Course Name	**:**	**SOLID STATE PHYSICS**
Course Code	**:**	**PYN-403**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
During this course students will understand basics of free electron theory. They will study the origin of energy gaps on the basis of quantum mechanics approach. They will cover advance topics in dielectrics. Superconductivity will also be covered and student's interest will be created in possibility of high temperature superconductivity.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Free electron theory, energy levels in one dimension, free electron gas in three dimension, heat capacity of electron gas, electrical conductivity and ohm's law, experimental electrical resistivity of metals, Hall Effect.	12
2	Energy bands, origin of energy gap, bloch functions, Kronig-Penny model, brillouin zones, metals and insulators.	10
3	Dielectric function of the electron gas, plasma optics, dispersion relation of electromagnetic wave, transverse optical modes in plasma, longitudinal plasma oscillations, polaritons, electron-phonon interaction polarons, optical processes and excitons.	12
4	Occurrence of superconductivity, destruction of superconductivity, Meissner effect, type I and type II superconductors, heat capacity, isotope effect, thermodynamical considerations, London equations & penetration depth, coherence length, BCS theory (elementary description), applications of superconductors. High temperature superconductivity, Josephson junctions.	8

Course Outcomes: By the end of the course, student will be able to	
1	Solve the problems based on free electron theory and band theory of solids.
2	Understand and apply the basic concepts of plasma optics and superconductivity in different phenomena.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Introduction to Solid State Physics", Charles Kittel, Wiley India Pvt. Ltd., New Delhi	2012
2	"Solid State Physics", S.O. Pillai, New Age International (P) Limited, New Delhi	2010
3	"Crystallography Applied to Solid State Physics", Verma and Srivastava, New Age International (P) Limited, New Delhi	2012

Course Name	**:**	**MODERN INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS**
Course Code	**:**	**CHN 401**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course, the student should be able to introduce the principles of chemical analysis, matrix effects, detailed instrumentation, operation and interpretation of data, error analysis and statistical methods of data handling.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**SPECTROSCOPIC TECHNIQUES:** UV – Visible, Infra red, NMR, and Mass Spectroscopy-Principles Instrumentation and Applications	10
2	**ATOMIC ABSORPTION SPECTROMETRY AND EMISSION SPECTROMETRY:**	8

	Inductively coupled plasma atomic emission spectroscopy (ICP-AES) - Principles Instrumentation and Applications	
3	**OPTICAL MICROSCOPY**: Scanning Electron Microscopy (SEM),Transmission Electron Microscopy (TEM) and Scanning Transmission Electron Microcopy (STEM) -Principles and Applications	6
4	**X-RAY TECHNIQUES**: XRD, XRF, XPS-Principles and Applications	8
5	**THERMAL ANALYSIS**: DTA, TGA- Principles Instrumentation and Applications	5
6	**CHROMATOGRAPHIC ANALYSIS**: GC, HPLC- Principles Instrumentation and Applications	5

Course Outcomes: By the end of this course, the student will be able to:	
1	Handle the analysis of mg, ppm and ppb levels of analyte by appropriate instrumental methods.
2	Carry out Chemical analysis of hazardous materials, environmental samples, inorganic, organic and biomaterials at trace and ultra trace quantities.
3	Differentiate among molecular absorption, atomic absorption and atomic emission spectrometry.
4	Carry out hands on experiments in the field related to analysis of materials required for technological developments and in advanced research in Engineering.
5	Differentiate between classical and instrumental methods of Chemical analysis.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Interpretation of Mass Spectra", McLafferty F.W., 3rd Edition, Pubs: W.A. Benzamine, New York.	1993
2	"Spectrometric Identification of Organic Compounds", Silverstein R.M. and Bassler G.S., 5th Edition, Pubs: John Wiley.	1991
3	"Instrumental Analysis", Willard H.H., Merritt L.L. and Dean J.A., 7th Edition, Pubs: Van Nostran Reinhold.	1998
4	"Instrumental Analysis", Skooq D.A. Holler F. J. and Crouch S. R., Pubs: Brooks/Cole.	2007
5	"Analytical Chemistry", Christian G.D., 5th Edition, Pubs: John Wiley.	1994
6	"X-ray structure determination a practical guide", Stout G.H. and Jeansen L.H., Pubs: John Wiley & Sons, New York.	1989
7	"Crystal structure analysis for chemists and biologists", Glusker J.P., Lewis M, Pubs: VCH Publisher inc., New York.	1994
8	"Structure Determination by X-ray crystallography", Ladd, M.F.C. and Palmer R.A., Pubs: Plenum Press, New York.	1994

Course Name	**:**	**PRINCIPLES OF MANAGEMENT**
Course Code	**:**	**HSM 401**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:

The main aim of this course is to make students understand the management process and principles along with its application in practical life and to help them manage different jobs and situations with the help of management functions.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO MANAGEMENT** Nature of Management: Art or Science, Principles and Functions of Management	**3**
2	**EVOLUTION OF MANAGEMENT THOUGHT**	**6**

	Classical Theories: Bureaucratic, Scientific and Administrative Approach Neo-Classical Theories: Human Relations and Human Behaviour Approach Modern Theories of Management Relevance of Management Thought in present scenario – Management Cases	
3	**PLANNING** Nature of Planning, Planning Process, Application of Planning Process in a Hypothetical Situation, Types of Planning, Types of Plans, Management by Objective (MBO)	**4**
4	**ORGANIZING** Concept of Organization, Departmentation, Forms of Organization Structure Analysis of Organization Structure – Case Studies Hypothetical Formation of an Organization	**4**
5	**STAFFING** Human Resource Planning: HRP Process, Job Analysis: Job Description, Job Specifications and Used of Job Analysis Recruitment: Sources and Methods Selection: Selection Process, Role Playing and Case Study on Selection Tests and Interviews Training and Development: Techniques, Performance Appraisal: Methods Case Study on Staffing Practices	**6**
6	**DIRECTING** Concept, Leadership: Importance and Styles, Motivation: Theories and their relevance in present scenario, Communication: Process, Types and Barriers of Communication Management Game on Leadership, Motivation and Communication	**3**
7	**CONTROLLING** Nature and Process of Controlling, Requirements for Effective Controlling	**2**

Course Outcomes:	
1	The students will be able to apply management concepts and principles in daily life and thus, will be able to manage things efficiently and effectively.
2	The students will learn how to get work done easily by using management knowledge and functions.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Principles and Practices of Management", Rao V.S.P. and Narayana P.S., Pubs: Konark Publishers.	1987
2	"Principles & Practice of Management", Prasad L.M., 8th Edition, Pubs: Sultan Chand & Sons.	2012
3	"Essentials of Management: International and Leadership Perspective", Weihrich H. and Koontz H., 9th Edition, Pubs: McGraw Hill.	2012
4	"The New Era of Management", Daft R.L., 11th Edition, Pubs: Cengage Learning.	2014
5	"Management: Text and Cases", Rao V.S.P. and Krishna V.H., Pubs: Excel Books.	2008
6	"Fundamentals of Management: Essential Concepts and Applications", Robbins S.P, DeCenzo D.A., Bhattacharya S. and Agarwal M.N., 6th Edition, Pubs: Pearson India.	2009

Course Name	**:**	**BUSINESS ENVIRONMENT AND BUSINESS LAWS**
Course Code	**:**	**HSM 402**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:
The main aim of this course is to make students understand different types of environment influencing business decisions and to provide knowledge about different laws that needs to be followed for initiating and managing business.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO BUSINESS** Scope and Characteristics of Business, Classification of Business Activities Forms of Ownership of Business: Sole Proprietorship, Partnership and Company	**5**
2	**BUSINESS ENVIRONMENT** Internal Environment: Concept and Elements (Value System, Vision Mission Objectives, Management Structure, Human Resources, Company Image etc.) SWOT Analysis: Concept and Case Study External Environment: Micro Environment (Suppliers, Customers, Competitors, Market Intermediaries etc.) and Macro Environment – PESTEL Analysis (Political, Economic, Social, Technological, Ecological and Legal), Case Study on Impact of Environment on Business	**7**
3	**GLOBALIZATION** Concept, Pros and Cons of Globalization, Impact of Global Environment on Business Globalization of Company – Case Study	**4**
4	**CORPORATE SOCIAL RESPONSIBILITY** Concept, Social Responsibility towards different stakeholders, Rationale for CSR CSR – Case Studies	**2**
5	**CORPORATE GOVERNANCE** Concept, Elements and Essentials of Good Governance	**3**
6	**CONTRACT LAW** Concept, Types and Essentials Elements of Contract	**3**
7	**PARTNERSHIP LAW** Nature of Partnership, Provisions of Partnership Act, Issues Related to Partnership Firm, Hypothetical Formation of a Partnership Firm	**2**
8	**COMPANY LAW** Nature of Company, Provisions of Company Act, Issues Related to Incorporation of Company, Hypothetical Formation of a Company	**2**

Course Outcomes:	
1	The students will be able to analyze the impact of environment on business and formulate appropriate business strategies to compete in the competitive world.
2	The students will learn how companies follow corporate governance and social responsibility practices along with fulfilling economic objectives.
3	The students will gain knowledge about application and implementation of various business laws in practice.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Business Environment: Text and Cases", Cherunilam F., 22nd Edition, Pubs: Himalaya Publications.	2013
2	"Legal Aspects of Business", Pathak A., 5th Edition, Pubs: McGraw Hill Education.	2013

3	"Essential of Business Environment: Text, Cases and Exercises", Aswathappa K., 11th Edition, Pubs: Himalaya Publication.	2011
4	"Business Law Including Company Law", Gulshan S.S. and Kapoor G.K., 15th Edition, Pubs: New Age International (p) Ltd.	2011
5	"Business Law and Corporate Laws", Tulsian P.C., 1st Edition, Pubs: Sultan Chand Publishing.	2011
6	"Fundamentals of Business Organization & Management", Bhushan Y.K., 19th Edition, Pubs: Sultan Chand & Sons.	2013
7	"Corporate Governance: Principles, Policies and Practices", Fernando A.C., 2nd Edition, Pubs: Pearson India.	2011

Course Name	**:**	**FINANCIAL MANAGEMENT**
Course Code	**:**	**HSM 404**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:
The main aim of this course is to make students learn different financial decisions i.e. investing, financing and dividend, required to be taken by a company and provide knowledge about the functioning of the financial system (financial markets, financial institutions, financial services and financial instruments) of the country.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO FINANCIAL MANAGEMENT** Concept of Finance, Terminology Related to Finance, Financial Decisions, Factors Affecting Financial Decisions, Risk-Return Trade-Off	**3**
2	**FINANCIAL SYSTEM** Concept and Role of Financial System in Indian Economy	**2**
3	**FINANCIAL MARKETS AND INSTRUMENTS** Concept and Relevance of Money Market and Capital Market Money Market Instruments: Call Money, Treasury Bills, Commercial Papers, Certificate of Deposits Capital Market Instruments: Equity Shares, Preference Shares and Debentures Hypothetical Trading in Financial Markets	**5**
4	**FINANCIAL SERVICES** Nature and Functions of Financial Services: Merchant Banking, Mutual Funds, Factoring, Forfaiting, Credit Rating Case Study on Financial Services	**6**
5	**FINANCIAL INSTITUTIONS**	**2**

	Nature and Functions of Financial Institutions: Reserve Bank of India (RBI), Securities and Exchange Board of India (SEBI), Discount and Finance House of India (DFHI)	
6	**LONG TERM INVESTMENT DECISIONS** Capital Budgeting: Concept, Importance, Factors Techniques/Methods with Numerical Applications (Pay Back Period, Accounting Rate of Return, Net Present Value, Internal Rate of Return and Profitability Index), Case Study	**3**
7	**SHORT TERM INVESTMENT DECISIONS** Working Capital: Nature, Type and Factors Affecting the Requirement of Working Capital, Case Study	**2**
8	**FINANCING DECISIONS** Capital Structure: Essentials and Approaches of Capital Structure Sources of Finance (long-term and short-term), Financial Leverage: Concept and Numerical Application, Case Study	**3**
9	**DIVIDEND DECISIONS** Types of Dividend, Dividend Policy: Nature and Factors Affecting Dividend Policy, Case Study	**2**

Course Outcomes:	
1	The students will learn to make best combination of financial decisions by considering risk and return trade-off.
2	The students will identify how business can gain maximum through the financial system.
3	The students will understand how to manage funds effectively so as to maximize returns.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Financial Management", Shah P., 2nd Edition, Pubs: Dreamtech Press	2009
2	"Financial Markets and Services", Gordon E. and Natarajan K., 3rd Edition, Pubs: Himalaya Publishing House.	2006
3	"Financial Management: Theory and Practice", Chandra P., 8th Edition, Pubs: McGraw Hill Education (India).	2012
4	"Financial Management", Pandey I.M., 10th Edition, Pubs: Vikas Publishing House Pvt. Ltd., Noida.	2010
5	"Cases in Financial Management", Pandey I.M. and Bhat R., 3rd Edition, Pubs: McGraw Hill Education (India).	2012
6	"Financial Institutions and Markets: Structure, Growth and Innovations", Bhole L.M. and Mahakud J., 5th Edition, Pubs: McGraw Hill Education (India).	2009
7	"The Indian Financial System: Markets, Institutions and Services", Pathak B.V., 3rd Edition, Pubs: Pearson India.	2010
8	"Financial Management and Policy", Horne J.C.V. and Dhamija S., 12th Edition, Pubs: Pearson India.	2011

Course Name	**:**	**MARKETING MANAGEMENT**
Course Code	**:**	**HSM 405**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:
The main aim of this course is to make students understand about the marketing concepts to be applied in real life and the marketing process for delivering value to customers.

Total No. of Lectures –28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO MARKETING** Concepts, Role, Scope and Types of Marketing, Case Study on Marketing Management	**3**
2	**MARKETING RESEARCH** Scope and Process of Marketing Research, Hypothetical Marketing Research Analysis	**3**
3	**CONSUMER AND BUSINESS MARKETS** Types of Markets, Building Customer Value Consumer and Business Buying Behaviour: Factors Influencing Behaviour and Buying Decision Process	**4**
4	**SELECTION OF MARKETS** Segmentation: Factors and Bases, Targeting and Positioning Preparation of STP of Selected Product	**3**
5	**MARKETING MIX** 7 P's of Marketing Mix: Product, Price, Physical Distribution, Promotion, People, Process and Physical Evidence Formulation of Marketing Mix of Selected Product	**3**
6	**PRODUCT DECISIONS** Product (Good or Service) Characteristics, Product Life-Cycle, Packaging and Branding, Product Development and Management	**3**
7	**PRICING DECISIONS** Pricing Policies and Strategies, Factors Influencing Pricing	**3**
8	**PHYSICAL DISTRIBUTION DECISIONS** Marketing Channels, Channel Players, Physical Distribution, Managing Distribution, Analysis of Supply Chain Management – Case Studies	**3**
9	**PROMOTION DECISIONS** Nature of Promotion Decisions, Managing Mass Communication and Personal Communication Analysis of Promotional Strategies – Case Studies	**3**

Course Outcomes:	
1	The students will learn how to market goods and services effectively to different segments so as to deliver value to customers.
2	The students will be able to formulate marketing mix and marketing strategies for different products and different sets of customers.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Marketing Management: Concepts, Cases, Challenges and Trends", Govindarajan M, 2nd Edition, Pubs: PHI Learning.	2009
2	"Marketing Management", Kotler P., Keller K.L., Koshy A. and Jha M., 14th Edition, Pubs:	2012

	Pearson India.	
3	"Marketing Concepts and Strategies", Dibb S., Simkin L., Pride W.M. and Ferrell O.C., Pubs: Cengage Learning.	2012
4	"Marketing Management", Kumar A. and Meenakshi N., 2nd Edition, Pubs: Vikas Publishing House Pvt. Ltd., Noida.	2011
5	"Marketing Management", Saxena R., 4th Edition, Pubs: McGraw Hill Education (India).	2013
6	"Marketing: Managerial Introduction", Gandhi J.C., 1st Edition, Pubs: McGraw Hill Education.	1987
7	"Marketing", Etzel M.J., Walker B.J., Stanton W.J. and Pandit A., 14th Edition, Pubs: McGraw Hill Education (India).	2010
8	"Super Marketwala: Secrets to Winning Consumer India", Mall D., 1st Edition, Pubs: Random House India.	2014

Course Name	**:**	**HUMAN RESOURCE MANAGEMENT**
Course Code	**:**	**HSM 406**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:
The main aim of this course is to provide an overview of HRM, keeping the Indian business scenario in the background and to acquaint the students with the strategic role of HRM in managing an organization.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO HUMAN RESOURCE MANAGEMENT** HRM: Nature, Scope, Functions, HRM Practices and Problems in India with Case Studies	**4**
2	**HUMAN RESOURCE PLANNING (HRP)** Concept and Process of HRP, Factors Affecting HRP	**3**
3	**JOB ANALYSIS AND DESIGNING** Uses and Process of Job Analysis, Job Description and Job Specification: Features and Hypothetical Formulation, Job Designing: Job Enrichment, Job Enlargement	**3**
4	**RECRUITMENT AND SELECTION** Recruitment: Sources and Methods Selection: Selection Process, Selection Tests, Types and Nature of Interviews Role Playing and Case Study on Selection Process, Tests and Interview	**4**
5	**INDUCTION AND INTERNAL MOBILITY** Induction Programme, Need and Scope of Internal Mobility: Transfer, Promotion, Demotion	**3**
6	**TRAINING AND DEVELOPMENT** Training: Need and Methods, Management Development: Need, Methods and Management Development Programme	**4**

	HRM Games for Development of Employees	
7	**PERFORMANCE APPRAISAL AND COMPENSATION** Nature and Methods of Performance Appraisal, Hypothetical Performance Appraisal Compensation: Financial and Non-Financial Benefits	**4**
8	**EMPLOYEE HEALTH AND SAFETY** Concept, Issues related to Health and Safety, Workplace Health Hazards	**3**

Course Outcomes:	
1	The students will develop the ability to solve problems in area of HRM in organizations.
2	The students will become aware of latest developments in HRM practices which are essential for effective management in organization.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Human Resource Management: Text and Cases", Rao V.S.P., Pubs: Excel Books.	2002
2	"Human Resource Management", Dessler G. and Varkkey B., 12th Edition, Pubs: Pearson India.	2011
3	"Human Resource Management: Text and Cases", Aswathappa K., 7th Edition, Pubs: McGraw Hill Education (India).	2013
4	"Human Resource Management: Text and Cases", Gupta C.B., 14th Edition, Pubs: Sultan Chand and Sons.	2012
5	"Human Resource Management: Text and Cases", Bedi S.P.S. and Ghai R.K., Pubs: Bharti Publications.	2012
6	"Human Resource Management Applications: Cases, Exercises, Incidents and Skill Builders", Fottler M.D., McAfee R.B. and Nkomo S.M., 7th Edition, Pubs: Cengage Learning.	2013

Course Name	**:**	**MANAGING INNOVATION AND CHANGE**
Course Code	**:**	**HSM 431**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:
The main aim of this course is to make students learn how to manage innovation and change in organizations and understand how innovation and change can contribute to business success.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO INNOVATION AND CHANGE** Concept, Types, Sources, Components, Invention vs. Innovation	4

2	**INNOVATION IN ORGANIZATION** Innovation in Managerial Functions (Planning, Organizing, Staffing, Directing and Controlling), Innovation in Operational Functions (Marketing, Human Resource and Finance) Case Studies and Brainstorming Sessions	3
3	**INNOVATION POLICY** Innovation Cluster, National Innovation Systems	3
4	**INNOVATION MANAGEMENT** Innovation Management: Innovation Strategies, Models, Processes and Structures Case Study on Innovation Management	4
5	**REACTIONS TO CHANGE** Process of Planned Change, Responses to Change, Reasons for Resistance to Change, Change Agents, Stages in Reaction to Change	5
6	**CHANGE MANAGEMENT** Key Dimensions and Factors, Organizational Change, Approaches to Change Management Case Study on Change Management	4
7	**INTELLECTUAL PROPERTY RIGHT (IPR)** Patents, Copyrights and Trademarks	3
8	**DISCUSSIONS ON ADDITIONAL READING** (any one of the following in the semester) - 8 Steps to Innovation – Going from Jugaad to Excellence - Innovation Secrets of Indian CEOs - Jugaad Innovation: A Frugal and Flexible Approach to Innovation for the 21st Century - The Ten Faces of Innovation	2

Course Outcomes:	
1	The student will learn the technological, human, economic, organizational, social and other dimensions of innovation.
2	The students will understand how to encourage, manage and implement innovation and change in organization and how to take a new idea to the stage where it can be implemented.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Managing Change and Transition", Harvard Business School, Pubs: Harvard University Press.	2003
2	"Managing Creativity and Innovation", Harvard Business School, Pubs: Harvard University Press.	2003
3	"Managing Change, Creativity and Innovation", Dawson P. and Andriopoulos C., Pubs: Sage Publications.	2014
4	"Managing Strategic Innovation and Change", Tushman M.L. and Anderson P., 2nd Edition, Pubs: Oxford University Press.	2004
5	"The International Handbook of Innovation", Larisa V.S., Pubs: Elsevier Science.	2003
6	"Managing Innovation and Change", Mayle D., 3rd Edition, Pubs: Sage Publications.	2006
7	"Managing Technology and Innovation for Competitive Advantage", Narayanan V.K., Pubs:	2002

	Pearson India.	
8	"Managing Technological Innovation, Competitive Advantage from Change", Betz F., Pubs: Wiley.	2011

Course Name	**:**	**BUSINESS RESEARCH**
Course Code	**:**	**HSM 432**
Credits	**:**	**4**
L T P	**:**	**2-2-0**

Course Objectives:
The main aim of this course is to make students understand the concepts of business research and learn the methods to formulate, analyze and interpret the business problems.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO BUSINESS RESEARCH** Concept and Types of Business Research	3
2	**PROBLEM IDENTIFICATION** Defining Problem, Literature Review: Essentials of Literature Review and Writing of Review, Research Objectives: Essentials of Research Objectives and its Formulation	3
3	**FRAMEWORK FOR BUSINESS RESEARCH** Research Questions, Hypothesis: Essentials of Hypothesis and its Formulation, Types of Variables	2
4	**INTRODUCTION TO RESEARCH DESIGN** Purpose and Scope of Research Design, Research Proposal: Elements and Framing a Research Proposal	2
5	**MEASUREMENT SCALES** Rating Scales, Ranking Scales, Reliability, Validity, Questionnaire: Essentials of Questionnaire, Developing a Questionnaire on a Hypothetical Research Problem	4
6	**SAMPLING DESIGN** Concept, Process and Techniques of Sampling, Framing of Sampling Design	3
7	**DATA COLLECTION** Sources and Methods of Data Collection	3
8	**PRESENTATION AND ANALYSIS OF DATA** Tabular, Graphic and Diagrammatic Presentation of Data, Statistical Data Analysis, Presentations and Analysis of Data using MS Excel	5
9	**RESEARCH REPORT** Contents and Characteristics of Project Report, Formulation of Project Report	3

Course Outcomes:	
1	The students will develop ability to tackle problems in business by following research techniques.
2	The students will learn to collect the right data and to analyze and present the data in the right way.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Research Methods for Business: A Skill Building Approach", Sekaran U. and Bougie R., 5th Edition, Pubs: Wiley India Pvt. Ltd., New Delhi.	2011

2	"Research Methodology: Methods and Techniques", Kothari C.R. and Garg G., 3rd Edition, Pubs: New Age International.	2014
3	"Business Research Methods", Bryman A. and Bell E., 2nd Edition, Pubs: Oxford University Press.	2010
4	"Business Statistics", Beri G.C., 3rd Edition, Pubs: McGraw Hill Education (India).	2009
5	"Statistics for Management", Levin R.I., Rubin D.S., Rastogi S. and Siddiqui M.H., 7th Edition, Pubs: Pearson India.	2012
6	"Business Research Methods and Statistics using SPSS", Burns R.P. and Burns R., 1st Edition, Pubs: Sage Publications.	2008
7	"Statistics for Management", Srivastava T.N. and Rego S., 2nd Edition, Pubs: McGraw Hill Education (India).	2012

Course Name	**:**	**ALGEBRA - I**
Course Code	**:**	**MAN 431**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to describe the basic results of Group Theory. They should be able to recognise examples of groups. They should know the definitions of basic terms and should be able to write elements of the symmetric group as cycles or products of transpositions, should know simple uses of Lagrange's Theorem, quotients and products of groups. They should know difference between finding a proof from the axioms that works for all groups, and finding a counter example.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Definition of a group, examples, some preliminary lemmas, Subgroups, examples, Cosets, Order of a group, Lagrange's Theorem,Euler's Theorem, A counting principle.	10
2	Normal subgroups and quotient groups, Homomorphism, Cauchy's Theorem, Sylows Theorem, Automorphism, Cayley's Theorem, Permutation groups, Conjugacy classes, Sylow subgroups and Sylow's Theorem,	16
3	Direct products, Finite abelian groups.	6
4	Vector Spaces: Elementary basic concepts, Linear independence and bases, Dual Spaces.	10

Course Outcomes:	
1	By the end of the course, the students will be able to describe the basic results of Group Theory, recognise examples of groups, know the definitions of basic terms, such as: order of a group, order of an element, subgroup, cyclic group and isomorphism. They will also be able to prove simple consequences, write

	elements of the symmetric group as cycles or products of transpositions, describe quotients and products of groups.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Topics in Algebra", Herstein, I.N., Wiley Eastern Limited, New Delhi.	1981
2	"Modern Algebra", Singh, S and Zameeruddin, Q ,Vikas Publishing House, New Delhi	2015
3	"Rings and Modules", Musili, C, Narosa Publishing House, (Second Revised Edition),New Delhi.	1994.
4	"Algebra", Artin, M. Prentice Hall of India, New Delhi.	1994
5	"The Theory of Groups of Finite Order", Burnside, W. (2nd Ed.), Dover, New York.	1955

Course Name	**:**	**NUMBER THEORY**
Course Code	**:**	**MAN 432**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to describe the fundamental properties of integers and to prove basic theorems. They should be able to solve congruences and Diophantine equations. They should also be able to approximate reals by rationals.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Introduction, Divisibility, Greatest common divisor, The Euclidean algorithm, primes, Fundamental theorem of Arithmetic,	8
2	Congruences, Residue classes and reduced residue classes, Fermat's theorem, Euler's theorem, Wilson Theorem, Solution of congruences , congruences of degree1, Chinese Remainder theorem with applications. Euler's φ-function,	12
3	Congruences of higher degree, prime power modulii, prime modulus, Primitive roots, Indices and their applications, power residues, Quadratic residues, Quadratic reciprocity, Legendre Symbol, Euler's criterion, Gauss's Lemma, Quadratic reciprocity law, Jacobi symbol,	10
4	Greatest integer function, arithmetic function, Mobius inversion formula, Diophantine equations Farey sequences,Continued fractions, approximations of reals by rationals.	12

Course Outcomes: By the end of the course, the students will be able to	
1	Describe the fundamental properties of integers.
2	Prove basic theorems.
3	Solve congruences.
4	Sove Diophantine equations
5	Approximate reals by rationals

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/**

		Reprint
1	"An introduction to theory of numbers", Niven I., Zuckerman S. H. and Montgomary L. H.John Wiley and Sons .	1991
2	"Theory of Numbers", Hardy and Wright W. H.Oxford University Press	1979
3	"Higher arithmetic", Davenport H.Cambridge University Press .	1999.
4	"Elementary Number Theory", David M. Burton, Wm.C.brown Publishers, Dubuque, Ivova .	1989

Course Name	**:**	**FOURIER SERIES AND INTEGRAL TRANSFORMS**
Course Code	**:**	**MAN 433**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to expand functions in Fourier series, Fourier Integrals and learn Fourier sine and cosine Transforms, Harmonic analysis and their applications. The students should be able to evaluate Laplace transforms and Inverse Laplace transform. The students should be able to apply Laplace transforms to solve ordinary differential equations.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Periodic functions, Trigonometric series, Fourier Series, Euler's formulae, Conditions for existence of Fourier series, Functions of any period p = 2L, Even and odd functions, Half range expansions, Complex Fourier series, Applications of Fourier series, Parseval's identity, Harmonic analysis. Approximation by Trigonometric Polynomials	12
2	Fourier Integral, Fourier Sine and Cosine Integrals ,Evaluation of Integrals, Fourier Transforms, Fourier Cosine Transform, Fourier Sine Transform, Properties of Fourier Transform, Linearity ,Symmetry, change of Time Scale, Time Shifting , Frequency Shifting , Fourier Transform of derivatives, integrals, convolution , Properties of Fourier cosine and sine Transforms, Parseval Identity for Fourier Transform , Finite Fourier Cosine and Sine Transform	18
3	Laplace transform, Inverse transform, properties, Transforms of derivatives and integrals, s-Shifting ,t-Shifting, Unit step function, Dirac's delta function, Differentiation and integration of transforms, Applications to differential equations. Convolution Theorem ,Integral Equations	12

Course Outcomes:	
1	By the end of this course the students will be able to expand a function in terms of its Fourier Series ,Fourier Integrals, Fourier Transforms and apply harmonic analysis to numerical data.
2	The students will be able to evaluate Laplace transforms and inverse Laplace transforms.
3	The students will be able to use Laplace transform to solve ordinary differential equations arising in engineering problems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Higher Engineering Mathematics", B V Ramana, Tata McGraw -Hill	2006
2	"Advanced Engineering Mathematics", E. Kreyszig, John Wiley.	2006
3	"Advanced Engineering Mathematics", Wylie and Barrett, McGraw Hill.	2003

Course Name	**:**	**CALCULUS OF VARIATIONS**
Course Code	**:**	**MAN 434**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of the course the students should be able to understand the concept of functional, extremum, Euler's equations, the concepts of transversality conditions, Weirstress-Endmann corner condition and canonical form of Euler equations, canonical transformations and Rayleigh Ritz method,They should be able to apply direct methods in calculus of variations Euler's finite difference methods, use Rayleigh Ritz method and Sturm-Liouville to solve differential equations.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Variation of a functional. A necessary condition for an extremum, Euler's equation. Some classical problems. Fixed end point problems for unknown functions. Variational problems with subsidary conditions.	10
2	General variation of a functional. Variable end point problems, transversality conditions. Transversal theorem. Weirstress-Endmann corner condition. Canonical form of Euler equations and their first integrals. Canonical transformations. Weather's theorem. The principle of the least action. Censervation laws. Hamilton-Jacobi equations. Jacobi's theorem.	14
3	The second variation of a functional and the formula for second variation. Legendre's necessary condition. Iaoobi's necessary condition. Conjugate points, Sufficient condition for a weak extremum. General definition of a field and field of a functional. Hilberts invariant integral. The weierstrass E-functional. Sufficient conditions for a strong minimum. Direct methods in calculus of variations Euler's finite difference methods and the Rayleigh Ritz method. Applications to sturm-Liouville problem.	18

Course Outcomes:	
1	At the end of the course the students will be able to understand the concept of functional, extremum, Euler's equations.
2	They will be able to learn the concepts of transversality conditions, Weirstress-Endmann corner condition and to evaluate canonical form of Euler equations, canonical transformations and Rayleigh Ritz method.
3	They will be able to apply direct methods in calculus of variations Euler's finite difference methods, use Rayleigh Ritz method and Sturm-Liouville to solve differential equations.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Calculus of variations", I M. Gelfand and S. V. Fomin	1963
2	"Calculus of variations", L.E. Elsgolc.	1962

Course Name	**:**	**ALGEBRAIC CODING THEORY**
Course Code	**:**	**MAN 435**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Course Objectives:
At the end of this course, the students should be able to translate fundamental problems of coding theory into mathematical problems and then solve them by using the theory of finite fields, polynomial rings and finite groups.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO CODING THEORY** Source and Channel coding, Error detecting and error correcting codes	2
2	**ERROR DETECTION, ERROR CORRECTION AND DECODING** Communication Channels, maximum likelihood decoding, Hamming distance, Nearest neighbour/ minimum distance decoding, distance of a code	6
3	**FINITE FIELDS** Fields, Polynomial rings, Structure of finite fields, Minimal polynomials	10
4	**LINEAR CODES** Vector spaces over finite fields, Linear Codes, Hamming weight, Bases for linear codes Generator matrix and parity check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes, Cosets, Nearest neighbor decoding for linear codes, Syndrome Decoding, Weight Enumerator of a Code, Macwilliam's Identity,	16
5	**CYCLIC CODES** Definition, Generator polynomials, Generator matrix and parity check matrix, Decoding of linear codes.	8

Course Outcomes: By the end of the course, the students will be able to	
1	Translate fundamental problems of coding theory into mathematical problems and then solve them by using the theory of finite fields, polynomial rings and finite groups.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Coding Theory", San Ling & Chaoping Xing , Cambridge University Press	2004
2	"Introduction to the 'Theory of Error Correcting Codes", Vera Pless, Cambridge University Press	2003
3	"Introduction to Error Correcting Codes", Raymond Hill, Clarendon Press, Oxford	1986
4	"Theory of Error Correcting Codes Part I & II", F.J.Macwilliams & NJA Sloane	1977

Course Name	**:**	**QUANTUM MECHANICS**
Course Code	**:**	**PYN-431**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course the students should be able to describe and implement concepts and principles of Quantum Mechanics required for in depth understanding of Physical phenomena of materials in relation to applications in Engineering. The students should be able to solve numerical problems related to hydrogen atom.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	Blackbody radiation, photoelectric effect, X-rays, X-ray diffraction, Compton effect, Pair production	7
2	Inadequacy of classical physics, Bohr-Sommerfield quantization rules, Quantum-Mechanical viewpoint.	4
3	De Broglie waves, phase and group velocities, particle diffraction, Uncertainty Principle, limitations on experiment, wave packets.	7
4	One-dimensional Schrodinger wave equation, extension to three dimensional statistical interpretation of wave function, Normalization, expectation value.	6
5	Separation of wave equation, one-dimensional square well potential, perfectly rigid wall, finite potential step, tunnel effect.	8
6	Linear harmonic oscillator, three-dimensional square well potential, the hydrogen atom, separation of variables, quantum numbers, principal quantum number, orbital quantum number, magnetic quantum number, Zeeman effect.	10

Course Outcomes: By the end of the course, student will be able to	
1	Solve the problems based on Quantum Mechanics.
2	Apply the concepts of Quantum Mechanics in different phenomena.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Concepts of Modern Physics", Arthur Beiser, McGraw Hill Education (India) Pvt. Ltd., New Delhi.	2013
2	"Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles", Robert Eisberg and Robert Resnick, Wiley India Pvt. Ltd., New Delhi	2013
3	"Modern Physics", J. Bernstein, P.M. Fishbane and S.G. Gasiorowicz, Pearson, Education India Pvt. Ltd., New Delhi	2009

Course Name	**:**	**STATISTICAL PHYSICS**
Course Code	**:**	**PYN-432**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The students will be able to describe and implement concepts and principles of Statistical Mechanics required for in depth understanding of Physical phenomena in solid state, nuclear physics.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	Laws of Thermodynamics - First Law of Thermodynamics, Second Law of Thermodynamics, Entropy, Third Law of Thermodynamics. Phase Transitions, Kinetic Theory, Vander waal equation of state, Boltzmann transport equation, Maxwell-Boltzman Distribution, the method of most probable distribution.	6 8
2	Classical Statistical Mechanics, Microcanonical ensemble, Cnonical ensemble, Grand Canonical ensemble, Chemical Potential.	7

	Distribution function, Ideal Fermi Gas, Degenerate and non-degenerate states, Theory of white dwarf stars, Landau Diamagnetism.	7
3	Equation of state for ideal Fermi gas, quantized Hall effect, Pauli paramagnetism, Ideal Bose gas, Bose-Einstein distribution, Derivation of Planck's Law. Phonons, Specific heat, superfluids, Landau's theory, superfuid flow, superfluid velocity, Bose-Einstein Condensation.	7 7

Course Outcomes:	
1	Solve the problems based on Statistical Mechanics.
2	Understand the importance of statistical physics in describing various natural phenomena.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Statistical Mechanics" , K. Huang, Wiley India Private Ltd., New Delhi	2013
2	"Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles", Robert Eisberg and Robert Resnick, Wiley India Pvt. Ltd., New Delhi	2013
3	"Concepts of Modern Physics", Arthur Beiser, McGraw Hill Education (India) Pvt. Ltd., New Delhi.	2013

Course Name	**:**	**NUCLEAR PHYSICS**
Course Code	**:**	**PYN-433**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
The students should be able to describe and implement concepts and principles of Quantum Mechanics required for in depth understanding of Physical phenomena of materials in relation to applications in Engineering. The students should be able to solve numerical problems related to hydrogen atom.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Mass, charge and constituents of nucleus, Nuclear size and distribution of nucleons, Energies of Nucleons, Nucleus as a quantum system, nuclear force, properties of nucleus.	10
2	Particle in a one-dimensional square well, particle in a three-dimensional square well, vector model for addition of angular momentum.	10
3	Bound states of two nucleons - Deuteron nucleus, Meson theory of nuclear forces. Shell theory of nucleus, shell theory potential, allowed orbits, filling of allowed orbits, non-spherical nucleus.	10
4	Natural radioactivity, successive radioactive transformations, radioactive equilibrium, radioactive series, radiometric dating. Nuclear force and its characteristics, Elementary description of shell model, explanation of magic numbers, liquid drop model and semi-empirical binding energy formula. Nuclear fission, fission products, mass and energy distribution of fission products, neutron emission and energy distribution of neutrons emitted in fission, theory of fission process, nuclear reactors - classification, neutron cycle in thermal reactors and four-factor formula for neutron reproduction, nuclear fission - controlled thermonuclear reactions.	12

Course Outcomes: By the end of the course, student will be able to

1	Solve the problems based on Nuclear Physics.
2	Understand and apply the basic concepts of nuclear physics in different nuclear phenomena.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Concepts of Nuclear Physics" , B.L. Cohen, Tata Mcgraw Hill, New Delhi	2013
2	"Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles", Robert Eisberg and Robert Resnick, Wiley India Pvt. Ltd., New Delhi	2013
3	"Introductary Nuclear Physics", Kenneth S Krane, Wiley India Pvt. Ltd., New Delhi	2014

Course Name	**:**	**EXPERIMENTAL NUCLEAR PHYSICS**
Course Code	**:**	**PYN-434**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of this course the students should be able to describe and implement concepts and principles of Quantum Mechanics required for in depth understanding of Physical phenomena of materials in relation to applications in Engineering. The students should be able to solve numerical problems related to hydrogen atom.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**Experimental Nuclear Physics** Binding energies of nuclei, semi-empirical mass formula, magnetic dipole moment, electric quadrupole moment, Beta decay, nucleon emission, decay laws.	10
2	Experimental method in nuclear physics, interaction of charged particle with matter, detectors for energetic charged particles, detectors which make tracks visually observable, scintillation detectors, charge collection detectors, mass spectrometer.	10
3	Accelerators, linear accelerator, cyclic accelerator, synchrocyclotron.	10
4	Natural radioactivity, successive radioactive transformations, radioactive equilibrium, radioactive series, radiometric dating. Nuclear force and its characteristics, Elementary description of shell model, explanation of magic numbers, liquid drop model and semi-empirical binding energy formula. Nuclear fission, fission products, mass and energy distribution of fission products, neutron emission and energy distribution of neutrons emitted in fission, theory of fission process, nuclear reactors - classification, neutron cycle in thermal reactors and four-factor formula for neutron reproduction, nuclear fission - controlled thermonuclear reactions.	12

Course Outcomes: By the end of the course, student will be able to	
1	Solve the problems based on experimental Nuclear Physics.
2	Predict that which type of detector or accelerator is suitable for particular application.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Concepts of Nuclear Physics" , B.L. Cohen, Tata Mcgraw Hill, New Delhi	2013
2	"Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles", Robert Eisberg and Robert Resnick, Wiley India Pvt. Ltd., New Delhi	2013
3	"Introductary Nuclear Physics", Kenneth S Krane, Wiley India Pvt. Ltd., New Delhi	2014

Course Name	**:**	**X-Ray Crystallography**
Course Code	**:**	**PYN-435**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:
At the end of the course, student will become familiar with the applications of X-ray crystallography in the determination of molecular structure. On the basis of structure, student will be able to explain the experimental observed properties.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	Bonding in Solids, Ionic bonding, Covalent, metallic bonding, intermolecular bond, dispersion bond, hydrogen bond. General features of crystals, basis and crystal structure, unit cell and lattice parameters, external symmetry of crystals, seven crystal systems, thirty two crystal classes, Miller indices, space lattice, symmetry elements, space group.	12
2	General description of scattering process, Thomson scattering, Compton scattering, scattering of X-rays by atoms.	10
3	Diffraction from one-dimensional and three-dimensional array of atoms, reciprocal lattice, Ewald sphere, Laue equation, structure factor, Diffraction by periodic distribution, electron-density equation, Patterson method. Powder camera, oscillation camera, Weissenberg camera.	10
4	Relevance of crystallography in the studies of theory of solids, influence of translational periodicity on the physical behavior of solids, tight binding approximation, density of states,	10

Course Outcomes:	
1	Solve the problems based on crystal systems.
2	Apply X-ray crystallography in the determination of molecular structure.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"An introduction to X-Ray Crystallography" by M.M. Woolfson Vikas Publishing House, Cambridge University Press, New Delhi	2012
2	"Solid State Physics", S.O. Pillai, New Age International (P) Limited, New Delhi	2010
3	"Crystallography Applied to Solid State Physics", Verma and Srivastava, New Age International (P) Limited, New Delhi	2012

Course Name	**:**	**INORGANIC CHEMISTRY**
Course Code	**:**	**CHN-431**
Credits	**:**	**4**
L T P	**:**	**3 0 3**

Course Objectives:
At the end of this course, the students should be able to describe concepts of Inorganic chemistry related to structure, properties & applications of inorganic and organometallic compounds.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**QUANTUM THEORY AND ATOMIC STRUCTURE:** Introduction to wave mechanics, the Schrodinger equation, the Schrodinger equation as applied to hydrogen atom, the origin of quantum numbers and shapes of orbitals.	4
2	**CHEMICAL BONDING:** Molecular orbital and valence bond theories of bond formation and application of molecular orbital theory to the formation of homonuclear and heteronuclear diatomic molecules.	7
3	**THE SOLID STATE:** A recapitulation of close packing of spheres, structures of NaCl, CsCl, ZnS, CaF2, crystal defects and applications of defect structures (transistors, rectifiers, photovoltaic cells and computer chips).	4
4	**COORDINATION COMPOUNDS:** Part 1: Werner's theory, effective atomic number, bonding of transition metal complexes: valence bond theory, crystal field theory, crystal field splitting in tetrahedral, octahedral and distorted octahedral (square planar) crystal fields. Thermodynamic aspects of coordination compounds (crystal field stabilization energies of octahedral and tetrahedral complexes, spectrochemical series).	6
5	**COORDINATION COMPOUNDS:** Part2: Kinetic aspects of coordination compounds (substitution reactions in complexes with coordination number 4 and 6 and their mechanism - SN^1, SN^2). Magnetic behaviour of complexes – Para magnetism, diamagnetism, ferromagnetism and antiferromagnetism	6
6	**ORGANOMETALLIC COMPOUNDS:** Nomenclature, types of ligands and bonding in organometallic compounds, use of organometallics in industry.	5
7	**INORGANIC POLYMERS:** Types of inorganic polymers, polyphosphazenes, polysiloxanes –their structures and properties.	5
8	**ROLE OF METALS IN BIOLOGICAL SYSTEMS:** Bio-inorganic Chemistry of Iron – Heme proteins & Non-Heme iron proteins; bioinorganic chemistry of cobalt-vitamin B12 and metalloenzymes.	5

List of Experiments:		**Number of Turns**
1	Estimation of oxalate using potassium permagnate.	1
2	Estimation of Fe^{2+} and Fe^{3+} using potassium dichromate.	1
3	Estimation of Cu^{2+} and AsO_3^{3-} iodimetrically.	2
4	Determination of Zn by EDTA titration.	1
5	Estimation of Ba^{2+}/SO_4^{2-} by as $BaSO_4$ gravimetrically.	1
6	Estimation of Fe^{2+} and Fe^{3+} as Fe_2O_3 gravimetrically.	2
7	Preparation and characterization of inorganic complexes (2 nos.).	2
8	Preparation and characterization of organometallic compound.	1
9	Crystallization techniques for purification of inorganic complexes.	1
10	Melting point determination of few inorganic compounds.	1

Course Outcomes: By the end of this course, the student will be able to:	
1	Understand the structure of atom based on quantum theory, concept of chemical bonding in homo- and hetro-atomic molecules & structure of advanced materials along with their applications in electronic fields.
2	Apply the thermodynamic, kinetic, magnetic and mechanistic aspects to coordination compounds.
3	Develope organometallic compounds to study the interaction and role of metals in biological systems essential for bio-engineering applications.
4	Design new inorganic materials with in-depth understanding of their structures and properties.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Inorganic Chemistry", A. G. Sharpe., 3rd Edition, Longman Publishers ELBS.	1992
2	"Inorganic Chemistry", J. D. Lee, 5th Edition, Chapman and Hall Publishers.	1996
3	"Advanced Inorganic Chemistry", F. A. Cotton & G. Wilkinson,3rd Edition, Wiley Eastern Ltd.	1982
4	"Basic Inorganic Chemistry", F. A. Cotton & G. Wilkinson; Wiley Eastern Ltd.	1987
5	"Inorganic Polymer", J. Mark, R. West & H. Allcock, Prentice Hall, New Jersey Publishers.	1982
6	"Vogel's Qualitative Inorganic Analysis", G. Svehla, 7th Edition Pearson Education.	2002

Course Name	**:**	
Course Code	**:**	
Credits	**:**	
L T P	**:**	

Course Objectives:

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**Ultrasonics** Production, detection and uses of ultrasonics, reverberation, sabine's formula (no derivation)	(3)
2		
3		
4		

List of Experiments:		**Number of Turns**
1		
2		
3		
4		
5		

Course Outcomes:	
1	
2	
3	
4	
5	

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	" Computer Graphics", Donald Hearn and M. Pauline Baker, Pearson Education	2012
2		

3		
4		
5		

Course Name	**:**	**ANALYTICAL CHEMISTRY**
Course Code	**:**	**CHN-433**
Credits	**:**	**4**
L T P	**:**	**310**

Course Objectives:
At the end of this course, the student should be able to develop sufficient knowledge about the major instrumental methods of chemical analysis so that they can determine what technique should be used for study of structural aspects of all kinds of materials. The student will be able to analyze the advances in instrumentation which have been made, especially those made as a result of problems encountered with the method. Students will gain practical knowledge of experimental methods and analytical instrumentation for carrying out analytical separations using gas and liquid chromatography.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**COMPLEXOMETRIC TITRATIONS :** Complexes-formation constants; chelates – EDTA, Chelon Effect, EDTA equilibria, effect of pH on EDTA equilibria, EDTA titration curves, endpoint – detection and indicators; Importance of complexometric titrations.	4
2	**SOLVENT EXTRACTION :** Distribution law, extraction process, factors effecting extraction, technique for extraction, quantitative treatment of solvent extraction equilibria, and classification of solvent extraction systems. Advantages and applications of solvent extraction.	6
3	**CHROMATOGRAPHY:** Introduction to chromatography, principles, classification of chromatographic techniques, thin layer and paper chromatography – principle and technique. Column Chromatography – Factors affecting column efficiency and applications. Gas – liquid chromatography – theory, instrumentation and applications. HPLC – instrumentation, method, column efficiency and applications.	8
4	**THERMOANALYTICAL METHODS :** Principle, classification of methods. TGA –Instrumentation, factors affecting results and analysis of data. Applications. DTG – Instrumentation, analysis of data and applications. DTA – Principle, Instrumentation and applications.	8
5	**SPECTROSCOPIC TECHNIQUES:** UV Introduction to spectroscopy, Lambert Beer s law, instrumentation and applications ,IR Introduction, basic principles, factors affecting IR group frequencies , Instrumentation and Applications ,NMR Basic principles, elementary ideas and instrumentation chemical shifts, spin-spin coupling.	10
6	**ELECTRON MICROSCOPY:** Scanning electron microscopy (SEM), Transmission Electron Microscopy (TEM) and Scanning Transmission Electron Microcopy (STEM) Principles and Applications	6

Course Outcomes: By the end of this course, the student will be able to:	
1	Address the problems of analyzing complex samples. This would include defining the problem, determining any constraints, choosing the best methodology, and determining how to test the methodology to prove its merits. Where there are alternatives the student should be able to define the advantages and

	disadvantages of each.
2	Interpret data from analytical separation methods and will understand approaches for the validation of these analytical.
3	Carry out hands on experiments in the field related to analysis of materials required for technological developments and in advanced research in Engineering.
4	Apply various analytical techniques for analysis of organic and inorganic materials.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Principles of Instrumental Analysis", by Skoog, D. A. & West D. M., 5th Edition, Saunders College Publishers, USA.	1998
2	"Fundamentals of Analytical Chemistry", Skoog, D. A. & West D. M., 7th Edition, Saunders College Publishers, USA.	2000
3	"Industrial Methods of Analysis", Willard, Merritt, Dean &Settle, 7th Edition.	1989
4	"Industrial Methods of Chemical Analysis", Galen W. Ewing, 5th Edition.	1985
5	"Spectrometric identification of Organic Compounds", Silverstein R. M. &Webster F.X., 6th Edition, John Wiley and Sons, Inc., USA	2005
6	"Quantitative Inorganic Analysis", A.I, Vogel, 5th Edition.	1989

Course Name	**:**	**ENVIRONMENTAL CHEMISTRY**	
Course Code	**:**	**CHN-434**	
Credits	**:**	**4**	
L T P	**:**	**3 1 0**	

Course Objectives:
At the end of this course, the student should be able to understand the basic knowledge of environmental chemistry, such as chemistry of atmosphere, hydrosphere, pedosphere and biosphere. The student will be able to apply basic theories and methods of chemistry to study the environmental issues caused by chemical substances (pollutants).

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	CHEMICAL COMPOSITION OF AIR : Classification of elements, chemical speciation. Particles, ions, and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Sources of trace gases in the atmosphere; Thermo-chemical and photochemical reactions in the atmosphere. Tropospheric oxidation chemistry; Oxygen and ozone chemistry. Chemistry of air pollutants. Role of hydrocarbons; Sulphur chemistry; Halogen Chemistry in the atmosphere.	8
2	WATER CHEMISTRY: Chemistry of water, dissolution / precipitation reactions; complexation reactions; concept of DO, BOD, COD; concept of salinity; composition of sea water and physic-chemical speciation in oceans; Suspended particles; concept of sedimentation, coagulation, filtration,	8
3	SOIL POLLUTION : Pollutants in soil, Agricultural Pollution, Role of Micro nutrients in soil, Ion exchange reaction in soil, Pesticide (Classifications & Degradation), Path of Pesticides in Environment, Monitoring techniques.	8
4	ENVIRONMENTAL TOXICOLOGY AND ITS EVALUATION: Emergence as a science; concepts and definitions; Factors affecting toxicity, Evaluation of LC50, LD50, LCIC and IT.	5

5	TOXIC CHEMICAL IN THE ENVIRONMENT : Metals and other inorganic contaminants; Organic contaminants; Fate of organic contaminants; Pesticides; Biochemical aspects of arsenic, cadmium, lead, mercury, carbon monoxide, ozone and PAN Pesticides; Insecticides, MIC, carcinogens in the air. Photochemistry of Brominated Flame Retardants (BFR) Gene toxicity of toxic chemicals.	8
6	GREEN CHEMISTRY FOR SUSTAINABLE FUTURE : Reagents, Media, Special Importance of Solvents, Water the Greenest Solvents, Synthetic and Processing Pathways, Role of Catalyst, Biological Alternatives, Biopolymers, Principles and Application of Green Chemistry.	5

Course Outcomes: By the end of this course, the student will be able to:	
1	Describe the chemical composition (and the main elements' occurrence forms) of the geosphere, the atmosphere, the hydrosphere, and the biosphere and to explain how interactions between these spheres and the techno sphere affect the environment.
2	Know the basic chemical features of some environmental concerns of today and their societal origin, with specific focus on acidification, eutrophication, ozone, nuclear wastes, heavy metals, organic pollutants, and climate change issues.
3	Develop integrated technologies to support the recycling of carbon and plant nutrients from agricultural crops, bio-based industries and municipal water treatment plants.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"Environmental Chemistry", Banerji, S.K, 2nd Edition, Prentice-Hall, New Delhi, India.	1999
2	"Environmental Chemistry", A. K. De, 4th Edition, New Age International (P) Ltd., New Delhi, India.	2000
3	"Introductory Chemistry for the Environment Science", Harrison, R. M. and de Mora, S. J. 2nd Edition, Cambridge University Press, New Delhi.	1996
4	"Introduction to Atmospheric Chemistry", Hobbes, P.B. Cambridge University Press, UK.	2000
5	"Principles of Environmental Chemistry", Kothandaaman, H. and Swaminathan, G. B.I. Publications, Chennai, India.	1997
6	"Fundamentals of Environmental Chemistry", Manahan, S. E. 2nd Edition, CRC Press, Inc., USA.	2001

Course Name	**:**	**RECENT ADVANCES IN CHEMICAL SCIENCES**
Course Code	**:**	**CHN-435**
Credits	**:**	**4**
L T P	**:**	**3 1 0**

Course Objectives:

At the end of this course, the student should be able to use molecular building blocks to design functional supramolecular constructs and nano-structured materials by using the principles of Supramolecular Chemistry. The student will be able to understand chemical and physical phenomena particular to surfaces and interfaces and reduce chemical pollutants flowing to the environment by using principles of Green Chemistry.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**SUPRAMOLECULES:** Concepts of supramolecular chemistry- Thermodymanics of molecular recognition,	8

	solvation, multivalency, Molecular Recognition: Cations,Anions and Neutral guests, Self processes - Self-assembly, Supramolecular -devices and Sensors, Molecular logic, photo switching materials, Supramolecular -material Chemistry Crystal engineering, MOFs and coordination polymers, templates for biomineralisation	
2	**CHEMISTRY OF NANOMATERIALS:** Synthesis of nanoparticles by chemical routes and characterization techniques: Thermodynamics and kinetics of nucleation; Growth of polyhedral particles by surface reaction, Ostwald ripening, size distribution; Properties of nanostructured materials : Optical properties; magnetic properties;	9
3	**HOMOGENEOUS CATALYSIS :** Stoichiometric reaction for catalysis, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reations involving carbon monoxide such as hydrocarbonylation of olefins (oxo reaction) oxopalladation reactions, activation of C-H bond.	8
4	**SURFACTANT AGGREGATION:** Micelles, Surface active agents, Classification of surface active agents, Micellization, Hydrophobic interaction, Critical micellar concentration (cmc), Factors affecting the concentration of surfactants, Counter-ion binding of micelle, Thermodynamics of micellization, Phase separation and Mass action models, Solubilization Emulsions, Mechanism of formation of microemulsion and their stability, Phase maps, Physical techniques, Applications..	9
5	**GREEN CHEMICAL PROCESSES:** An introduction to the tools of green chemistry and its fundamental principles. Use of Renewable Raw Materials. Evaluating feedstock and starting materials -commodity chemicals from glucose Greener Solvents: The use of supercritical fluids, and aqueous systems Greener reagents and products. Methods of designing safer chemicals Examples of greener reagents replacement of phosgene, methylations using dimethylcarbonate,	8

Course Outcomes: By the end of this course, the student will be able to:	
1	Exploit supramolecular engineering to design structures with adapted morphologies and properties.
2	Initiate self-assembly processes in bimolecular systems and the basis of bio-inspired chemistry.
3	Understand the interactions between surfaces and gases, liquids or solutions, and how interfaces are important in many technological a biological processes..
4	Identify the new advancements and approaches of chemical sciences for technological leads in various fields of sciences and Engineering.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	"The Organometallic Chemistry of the Transition Metals", Crabtree, R.G. 4th Edition, John Wiley.	2005
2	"Wilkinson Advanced Inorganic Chemistry", Cotton, F.A.; 6th Edition, John Wiley.	1999
3	"Supramolecular Chemistry",Steed J. W. and Atwood J. L., John Wiley and Sons, Ltd.	2000
4	"Green Chemistry and Catalysis",Roger Arthur Sheldon, Dr. Isabel W. C. E. Arends, Dr. Ulf Hanefeld, Wiley-VCH Verlag GmbH & Co. KGaA.	2007
5	"Physical Chemistry of Surfaces", Adamson A.W., Pubs: John Willey, New York.	1982
6	"Surfactant Science and Technology", Myers D., Pubs: VCH Publishers.	1988