Mohan Lal Sukhadia University
Udaipur

B. Tech. Program
(Effective from session 2021-2022)

Open Electives
Semesters VII-VIII

Syllabus

List and syllabus for Open Electives

List of Open Electives for Computer Science & Engineering				
Subject Code	**Title**		**Subject Code**	**Title**
Open Elective - I			**Open Elective - II**	
BT7AG6-60.1	Human Engineering and Safety		BT8AG6-60.1	Energy Management
BT7AG6-60.2	Environmental Engineering and Disaster Management		BT8AG6-60.2	Waste and By-product Utilization
BT7AN6-60.1	Aircraft Avionic System		BT8AN6-60.1	Finite Element Methods
BT7AN6-60.2	Non-Destructive Testing		BT8AN6-60.2	Factor of Human Interactions
BT7CH6-60.1	Optimization Techniques		BT8CH6-60.1	Refinery Engineering Design
BT7CH6-60.2	Sustainable Engineering		BT8CH6-60.2	Fertilizer Technology
BT7CR6-60.1	Introduction to Ceramic Science & Technology		BT8CR6-60.1	Electrical and Electronic Ceramics
BT7CR6-60.2	Plant, Equipment and Furnace Design		BT8CR6-60.2	Biomaterials
BT7CE6-60.1	Environmental Impact Analysis		BT8CE6-60.1	Composite Materials
BT7CE6-60.2	Disaster Management		BT8CE6-60.2	Fire and Safety Engineering
BT7EE6-60.1	Electrical Machines and Drives		BT8EE6-60.1	Energy Audit and Demand side Management
BT7EE6-60.2	Power Generation Sources.		BT8EE6-60.2	Soft Computing
BT7EC6-60.1	Principle of Electronic communication		BT8EC6-60.1	Industrial and Biomedical applications of RF Energy
BT7EC6-60.2	Micro and Smart System Technology		BT8EC6-60.2	Robotics and control
BT7ME6-60.1	Finite Element Analysis		BT8ME6-60.1	Operations Research
BT7ME6-60.2	Quality Management		BT8ME6-60.2	Simulation Modeling and Analysis
BT7MI6-60.1	Rock Engineering		BT8MI6-60.1	Experimental Stress Analysis
BT7MI6-60.2	Mineral Processing		BT8MI6-60.2	Maintenance Management
BT7PE6-60.1	Pipeline Engineering		BT8PE6-60.1	Unconventional Hydrocarbon Resources
BT7PE6-60.2	Water Pollution control Engineering		BT8PE6-60.2	Energy Management & Policy
BT7TT6-60.1	Technical Textiles		BT8TT6-60.1	Material and Human Resource Management
BT7TT6-60.2	Garment Manufacturing Technology		BT8TT6-60.2	Disaster Management

BT7AG6-60.1 : Human Engineering and Safety

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course. (This compulsory for all course)	01
2	*Human factors in system development* – concept of systems; basic processes in system development, performance reliability, human performance. Information input process, visual displays, major types and use of displays, auditory and factual displays.	09
3	Measurement of energy, direct and indirect methods. Energy cost of different activities and Acceptable work load. Noise and vibration, its measurement and control.	10
4	*Anthropometry:* arrangement and utilization of work space, atmospheric conditions, heat exchange process and performance.	10
5	Dangerous machine (Regulation) act, Rehabilitation and compensation to accident victims, Safety gadgets for spraying, threshing, Chaff cutting and tractor & trailer operation etc.	10
	Total	40

BT7AG6-60.2 : Environmental Engineering and Disaster Management

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course. (This compulsory for all course)	01
2	Importance of safe water supply system. Domestic water requirements for urban and rural areas. Sources of Water supply. Intakes and transportation of water.	09
3	Drinking water quality. Indian Standards of drinking water. Introduction to water treatment for safe drinking, Importance of sanitation.	10
4	*Domestic waste water:* quantity, characteristics, disposal in urban and rural areas. Sewer: types, design discharge and hydraulic design. Introduction to domestic wastewater treatment.	10
5	*Solid waste:* quantity, characteristics and disposal for urban and rural areas. Introduction to air pollution. Types of pollutants, properties and their effects on living beings. BIS standards for pollutants in air and their abetments. Introduction to various disaster, Importance of disaster management.	10
	Total	40

BT8AG6-60.1: Energy Management

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course. (This compulsory for all course)	01
2	Energy Basics; Energy Demand Management, Conservation & Resource Development, Energy for Sustainable Development.	09
3	Need for Energy Management by Sector- Industry, Buildings & Houses, Transport, Electric Power.	10
4	Need for Energy Management by Sector- Agriculture, Domestic; Energy forecasting techniques; Energy Integration, Energy Matrix.	10
5	Energy Auditing; Energy management for cleaner production, application of renewable energy, appropriate technologies.	10
	Total	40

BT8AG6-60.2 : Waste and By-product Utilization

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course. (This compulsory for all course)	1
2	Types and formation of byproducts and waste; magnitude of waste generation in different agro- processing industries; concept scope and maintenance of waste management and effluent treatment, basics pf Waste Recycling & Resources Recovery System (WRRRS), Temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues.	09
3	Waste utilization in various industries, furnaces and boilers run on agricultural wastes and byproducts, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization.	10
4	Waste treatment and disposal, design, construction, operation and management of institutional community and family size biogas plants, concept of vermi-composting, Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons.	10
5	*Tertiary treatments:* Advanced waste water treatment process-sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal, Assessment, treatment and disposal of solid waste.	10
	Total	40

BT7AN6-60.1: **Aircraft Avionic System**

Credit: 3 **Max. Marks: 150 (IA: 30, ETE: 120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Aircraft Electrical Power:** AC, DC & Emergency Power generation, voltage regulation, power distribution, inverters, transformers, rectifiers, circuit protection, external/ground power, Batteries installation and operation, Electronic emergency equipment requirements, cabin entertainment equipment, internal and external lightings of aircraft.	5
3	**Aircraft Instruments:** Generalized configurations and performance characteristics of instruments, motion requirement, relative displacement and velocity. Translational and seismic displacement, velocity and acceleration measurements. Torque measurement and rotating shaft, pressure and flow measurements. Fuel gauging systems, temperature based on expansion, electric resistance and radiation methods, Problems involved in temperature measurements, compensation techniques, and magnetic compasses. ESD, Electromagnetic Environment.	8
4	**Airborne Equipments:** Pressure measuring devices and systems, Pitot static system, Altimeters, VSI, ASI, Mach meter, Altitude reporting/alerting system, ADC, Instrument Pneumatic System, Direct reading pressure & temperature gauges and indicating systems. Fuel quantity indicating system, Gyroscopic principles, Artificial horizon, Turn & slip indicator, Directional gyro, GPS, Compass systems, Various Warning systems.	8
5	**Equipments Working:** Stall warning systems and angle of attack indicating system, Vibration measurement and Indication (HUMS), Compass system, FDR, FDS, Inertial navigation system, System operation: Electrical, fly by wire, Turn co-ordinator. Display System. Cockpit lighting, panels: integral, glopanels. Construction, Working and Maintenance of ECAM, EFIS, EICAS, FMS.	8
6	**Auto flight:** Fundamental of automatic flight control including working principles and current terminology Command signal processing, Various Modes of Operation, Autopilot navigation aids interface, Auto Throttle System.	5
7	**Automatic Landing System:** Principles and categories, modes of operation, approach, glide slope, land; go-around, system monitors and failure conditions. Avionics Systems & Fundamentals of System Layout	5
	TOTAL	40

BT7AN6-60.2: Non-Destructive Testing

Credit: 3 **Max. Marks: 150 (IA: 30, ETE: 120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Overview of NDT:** NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT, Visual inspection, Unaided and aided.	7
3	**Surface Non Destructive Evaluation (NDE) Methods:** Liquid Penetrant Testing, Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods. Testing Procedure, Magnetic Particle Testing, Theory of magnetism, inspection materials. Magnetisation methods, Interpretation and evaluation, Principles and methods of demagnetization, Residual magnetism.	8
4	**Thermography and Eddy Current Testing (ET):** Thermography, Principles, Contact and non contact inspection methods, Advantages and limitation, Instrumentations and methods, applications. Eddy Current Testing, Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.	6
5	**Ultrasonic Testing (UT) and Acoustic Emission (AE):** Ultrasonic Testing, Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A-Scan, B-scan, C-scan. Acoustic Emission Technique, Principle, AE parameters, Applications.	6
6	**Radiography (RT):** Principle, Interaction of X-Ray with matter, imaging, film and film less techniques, Types and use of filters and screens, Geometric factors, Inverse square, law, characteristics of films, Interpretation/ Evaluation, Fluoroscopy, Xero Radiography, Computed Radiography, Computed Tomography.	7
7	**Special Techniques and Applications:** Phased array ultrasonics time of flight diffractions, Automated and remote ultrasonic testing, Acoustic pulse reflectometry, Alternative current field method, Case studies on NDT techniques used in aircrafts.	5
	TOTAL	40

BT8AN6-60.1: Finite Element Methods

Credit: 3 **Max. Marks: 150 (IA: 30, ETE: 120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Review of Mathematics**: Introduction to FEM and its applications. Advantages of FEM, comparison with other methods such as FDM and FVM. Review of matrix algebra, Gauss elimination method, banded symmetric matrix and bandwidth.	4
3	**Discretization & Finite Element Formulation from Governing Differential Equations:** Geometrical approximations, Element shapes and behaviour, Choice of element types, size and number of elements, Location of nodes; p and h method of mesh refinement; Shape functions and their properties; Assembly and boundary conditions. General field problems, discrete and continuous models; Method of weighted residuals. Galerkin's method and other methods; Introduction to variational formulation (Ritz technique); Convergence of solution, compatibility.	8
4	**One-dimensional Finite Element Analysis:** One-dimensional second order equation, derivation of shape functions, Stiffness matrix and force vectors, assembly of elemental matrices, Derivation of finite elements equations using potential energy approach, 1-D bar element. Longitudinal vibration and mode shapes, fourth order beam equation, transverse deflections and natural frequencies, solution of problems from fluid mechanics and heat transfer.	8
5	**Two-dimensional Finite Element Analysis:** Finite element formulation using three node triangular (CST) element and four node rectangular element, Plane stress and Plain strain problems, node numbering and connectivity, Application to thermal problems.	6
6	**Finite Element Formulation from Governing Differential Equation:** Method of Weighted Residuals, Collocation, Sub domain method, Least Square method and Galerkin's method, Application to one dimensional problems, one-dimensional heat transfer, etc. introduction to variational formulation (Ritz Method.)	6
7	**Higher Order Elements:** Lagrange's interpolation formula for one and two independent variable, Convergence of solution, compatibility, element continuity, static condensation, p and h methods of mesh refinement, Aspect ratio and element shape, Application of FEM, Advantages of FEM, Introduction to concept of element mass matrix and Damping matrix in dynamic analysis, Calculation of natural frequencies and modes.	7
	TOTAL	40

BT8AN6-60.2: Factor of Human Interactions

Credit: 3 **Max. Marks: 150 (IA: 30, ETE: 120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Basic of Human Factor**: The need to take human factors into account. Incidents attributable to human factors/human error. 'Murphy's' law.	4
3	**Human Performance and Limitations:** Vision, Hearing, Information processing, Attention and perception, Memory, Claustrophobia and physical access.	5
4	**Social Psychology:** Responsibility: individual and group, Motivation and de-motivation, Peer pressure, 'Culture' issues, Team working, Management, supervision and leadership.	5
5	**Factors Affecting Performance:** Fitness/health, Stress, domestic and work related. Time pressure and deadlines. Workload, overload and underload. Sleep and fatigue, shift work. Alcohol, medication, drug abuse.	6
6	**Physical Environment and Task:** Noise and fumes. Illumination, Climate and temperature, Motion and vibration, Working environment. Physical work, Repetitive tasks, Visual inspection, Complex systems.	6
7	**Communication:** Within and between teams, Work logging and recording, Keeping up to date, currency, Dissemination of information.	5
8	**Human Error and Hazards in the Workplace:** Error models and theories, Types of error in maintenance tasks, Implications of errors (i.e accidents), Avoiding and managing errors. Recognizing and avoiding hazards, Dealing with emergencies.	5
	TOTAL	40

BT7CH6-60.1: Optimization Techniques

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction** Objective, scope and outcome of the course.	1
2	**Introduction and Classification** Basic concept of optimization, Mathematical formulation of optimization problems; applications of optimization in chemical engineering. Classification of Optimization Problems - single variable problems, Multivariable problems without constraints, Multivariable problems with constraints, Maximization and minimization problems. **Single Variable Optimization** Necessary and sufficient conditions for optimum; interpolation method quadratic. Region elimination methods-internal halving, Fibonacci.	12
3	**Multivariable Optimization** Optimization of Functions One Dimensional Search: Analytical Methods: classification, stationary points, direct substitution, constrained variation, penalty function, Lagrangian Multiplier, Kuhn-Tucker theorem. Numerical methods general principles of numerical search, direction of search, final stage in search, direct search, pattern search.	10
4	**Other Optimization Technics** Introduction to geometric, dynamic and integer programming and genetic algorithms. Application of Geometric Programming: chemical engineering problems with degree of difficulty equal to zero or one with constraints.	10
5	**Applications of Optimization** Optimization of staged and discrete processes. Optimal shell-tube heat exchanger design. Optimal pipe diameter.	7
	Total	40

BT7CH6-60.2: Sustainable Engineering

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Sustainability - Introduction, Need and concept of sustainability, Social environmental and economic sustainability concepts. Sustainable development, Nexus between Technology and Sustainable development, Challenges for Sustainable Development. Multilateral environmental agreements and Protocols - Clean Development Mechanism (CDM), Environmental legislations in India - Water Act, Air Act.	11
3	Air Pollution, Effects of Air Pollution; Water pollution- sources, Sustainable wastewater treatment, Solid waste - sources, impacts of solid waste, Zero waste concept, 3 R concept. Global environmental issues- Resource degradation, Climate change, Global warming, Ozone layer depletion, Regional and Local Environmental Issues. Carbon credits and carbon trading, carbon foot print. Environmental management standards, ISO 14000 series, Life Cycle Analysis (LCA) - Scope and Goal, Bio-mimicking, Environment Impact Assessment (EIA) - Procedures of EIA in India.	12
4	Basic concepts of sustainable habitat, Green buildings, green materials for building construction, material selection for sustainable design, green building certification, Methods for increasing energy efficiency of buildings. Sustainable cities, Sustainable transport. Energy sources: Basic concepts-Conventional and non-conventional, solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans, Geothermal energy.	10
5	Green Engineering, Sustainable Urbanisation, industrialisation and poverty reduction; Social and technological change, Industrial Processes: Material selection, Pollution Prevention, Industrial Ecology, Industrial symbiosis.	6
	Total	40

BT8CH6-60.1: Refinery Engineering Design

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Overview of Refinery:** Global and Indian Refining Industry, Refinery configurations, ASTM Distillation TBP Distillation, EFV distillation. Analysis of crude petroleum and its fractions. Different types of Boiling point, VABP, WABP, MABP, MeBP, CABP Computation of the curves , Calculation of ASTM temperature to TBP and EFV temperature, Average boiling points, Separation criteria in crude oil fractionation. Calculation for characterizing crude oil.	12
3	**Atmospheric distillation**: Atmospheric distillation tower, types of refluxes, pump around reflux pump back reflux top tray reflux, converting crude TBP to product TBP curves, concept of overflash. Energy balance in a topping tower and calculations involve estimation of top, side, bottom draw tray temperatures. Calculation of side steam strippers.	10
4	**Vacuum distillation:** Vacuum distillation tower, type of operations, Lube type Vacuum tower with pump back and pump around reflux heat removal. Lube or special vacuum distillation operation economic consideration in Vacuum Tower	10
5	**Fired Heater:** Types of fired heaters, Horizontal Types, Vertical Types, Codes and standards Burner, Gas burner Oil burner combination burners. Preparing refractories for operation stacks emissions, Basic constructional features of furnace, Different furnace types.	7
	Total	40

BT8CH6-60.2: Fertilizer Technology

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Nitrogenous Fertilizers** Macro and micro nutrients, Fertilizers Grades, Various fertilizers and their demand and production in India. Biofertilizer Methods of production of nitrogenous fertilizers: ammonium sulphate, ammonium nitrate, Urea, calcium ammonium nitrate; ammonium chloride. Characteristics, specifications, storage and handling of nitrogenous fertilizers.	10
3	**Phosphatic Fertilizers** Raw materials; phosphate rock, sulphur; pyrites etc. its application, Processes for the production of sulphuric and phosphoric acids. Phosphates fertilizers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate. Thermal phosphates and their methods of production, characteristics and specifications.	10
4	**Potassic Fertilizers** Methods of production of potassium chloride and its application. Potassium schoenite their characteristics and specifications. **Complex and NPK Fertilizers** Methods of production of ammonium phosphate, sulphate diammonium phosphate, nitro phosphates, urea, Ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilizers produced in the country.	10
5	**Miscellaneous Fertilizers** Mixed fertilizers and granulated mixtures; bio fertilizers, nutrients. Secondary nutrients and micro nutrients; fluid fertilizers, controlledrelease fertilizers, controlled release fertilizers.	9
	Total	40

BT7CR6-60.1: Introduction to Ceramic Science & Technology

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Content s	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction:** Ceramics as a class of material, bonding and structure of various ceramic materials; crystal structure and defects; chronological developments, structure of silicates; polymorphic transformations, raw materials	9
3	**Non crystalline materials:** structure, requirement for glass formation, Zachariasen rules, viscosity based transition points, devitrification; glass forming methods; important ceramic systems: one component system- silica; binary and ternary systems. Silicate glasses and glass	9
4	**Powder processing, pre-consolidation:** shape forming processes; Fundamental Sintering mechanisms, various advanced sintering techniques.	7
5	**Mechnacial behaviour of structural ceramics:** Brittleness of ceramics, Concept of fracture toughness and different toughness and strength measurement techniques; Concept of various toughening mechanisms	8
6	**Thermal, electrical, magnetic and optical properties of ceramic materials:** emphasis on the effects of composition, microstructure, processing, temperature and atmosphere on these properties. **Introduction to specific ceramic materials:** structure property correlation, processing and applications, superconductors, piezoelectrics, silicon carbide and nitride, sialons, cermets, bioceramics and bio-glass, cements, castables, refractories	8
	Total	42

BT7CR6-60.2: Plant, Equipment and Furnace Design

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Plant Design:** Plant location, plant layout, assembling of economic and engineering data, calculations pertaining to the processes, process vessels, etc. Flow Diagrams: Piping and instrument flow diagrams, process flow diagrams, design of a ceramic plant, Feasibility report and cost estimation of the plant. Economics of the plant, commercial aspects etc.	9
3	**Equipment Design:** Principles of design of the following process equipments: crushers, materials handling systems, filter press, sieves and pug-mills, moulding equipments. Principles of design of glass moulds such as blank mould, blow mould and neckringmoulds, Drying and different types of driers used in Ceramic industries: Drying and different types of driers used in Ceramic industries.	9
4	**Principles of design of simple supports:** footings and foundations for process equipments such as overhead tanks, motors, compressors and crushers. Different types of size- radiation equipment used in ceramic industry: Crushers and grinders including their design calculations.	8
5	**Chimney foundations:** Essential operations of a furnace i.e. firing, charging, melting, reversal. Preheating of air, gas and fuel oil, Flame systems: Temperature and its control. Thermal current in a glass, melting furnace, furnace atmosphere.	7
6	**Furnace life and selection of refractories:** Heating up and cooling down of a furnace, furnace construction, furnace capacity, fuel efficiency and firing efficiency, design, construction and thermal calculation pertaining to glass melting furnaces: Design, construction and thermal calculation pertaining to glass melting furnaces.	8
	Total	42

BT8CR6-60.1: Electrical and Electronic Ceramics

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Ferroelectric and Piezoelectric Ceramics:** Symmetry and other criteria of ferroelectricity, ferroelectric phase transitions. Effect of compositional modifications on properties of ferroelectric and piezoelectric ceramics. Piezoelectric transducers, Motors, Piezoelectric positioners, loudspeakers and gas igniters. Pyroelectric and electro-optic ceramics and their applications.	9
3	**Ceramic Capacitors:** Performance categories of ceramic capacitors with typical compositions. Multilayer and barrier layer capacitors.	8
4	**Thermistors and Varistors:** NTC and PTC thermistors, ZnO varistors and their applications	8
5	**Magnetic Ceramics:** Soft and hard magnetic materials. Spinels: crystal structure, magnetic structure and their properties, Hexaferrite: crystal structure, magnetic structure and their properties. Basic principle of magnetic recording, GMR materials.	8
6	**Superionic Solids:** Classification and structural features of superionic solids. Applications in oxygen sensors, fuel cells, high density energy storage batteries.	8
	Total	42

BT8CR6-60.2: Biomaterials

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Biomaterials Introduction:** Classes of biomaterials, Bulk Properties of Materials, Surface properties and surface characterization of materials, Properties of biomaterials: Physical, thermal, electrical and optical properties of bio-materials. Biocompatibility, Biofunctionality, Mechanical and Biological Testing of Biomaterials Metallic Implant Materials: Stainless steels, Co-based alloys, Ti and Ti-based alloys and Other metals	7
3	**Hard Tissues:** Structure of proteins, structure property relationship, hard tissue – healing & remodeling, biocompatibility, Physics of bone and structure of tooth, cortical bone versus trabecular bone structure.	7
4	**Hydroxy Apatite, Alumina and Zirconia in Surgical Implants:** Source, composition & structure, properties of hydroxyapatite, applications, biomaterials for artificial implant. Alumina and Zirconia; Source, composition & structure, mechanical properties, fatigue properties and service life, applications.	9
5	**Introduction to biological environments:** function and degradation of biomaterials in vivo swelling and leaching, corrosion and dissolution reactions of biological molecules with biomaterials surfaces, Mechanics of materials-deformation and failure: Mechanics of materials-deformation and failure, friction and wear, biological effect of implants inflammatory process, adaption, allergic foreign body response.	10
6	**Glass-Ceramics, Carbon Implants:** Formation of glass-ceramics, properties of glass ceramics, Coating & Composites: Source & structure of carbons, manufacturing of carbon implants.	8
	Total	42

BT7CE6-60.1: ENVIRONMENTAL IMPACT ASSESSMENT (Open Elective-I)

Credit 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course	1
2	**Introduction & Concepts of EIA**: effect of human activity on environment, concept of ecosystem imbalances, definition of E.I.A, E.I.S, E.M.P, industrial policy of the Govt. of India.	4
3	**International Protocols, Treaties and Conventions**: Stockholm and Basal convention, Copenhagen conference, Rio-Earth summit, **Indian Scenario:** Guidelines of MoEF and CPCB	4
4	**Methodologies for EIA**: preliminary assessment, quantification, comparison of alternatives and comprehensive E.I.As using Ad hoc, Overlays, Checklist, Matrix and Network methods	7
5	**Predictionandassessmentofimpacts**on air, water, biota, noise, land, cultural and socio-economic environment.	4
6	**Water quality impact:** Water quality criteria, standards and indices, Impacts on water quality of development projects. **Air quality impact:** Air quality criteria, standards and indices, air quality impact of industry transport systems	8
7	**Noise:** Effects of noise on people, noise scales and rating methods, Noise barriers, estimating transportation noise impacts. **Land Pollution** due to construction activities. **Biota:** Impact on fauna and flora, mitigation measures, alternatives.	4
8	**Cultural and socio economic impacts:** effect of developmental projects on cultural and social settings and economic profile of the community. **Energy impact:** EIA of hydro, thermal and nuclear power plants Public Participation in environmental decision making, Some Case Studies of EIA	8
	Total	40

Text / Reference Books:	
1	Anji Reddy Mareddy, Environmental Impact Assessment Theory and Practice, Elsevier Publication, IstEdition,2017
2	Introduction to Environmental Impact Assessment, A Guide to Principles and Practice, Oxford Publication, 3rdEdition,2015
3	Canter L. W. Environmental Impact Assessment, 2nd Ed., McGraw-Hill, 1997.
4	Burke,G., Singh, B.R., and Theodore, L. Handbook of Environmental Management and Technology, 2nd Ed., John Wiley & Sons,2000.
5	Kulkarni, V. and Ramachandra, T.V., "Environment Management", TERI Press. 2009.
6	MoEF Guidelines and amendments as updated onhttp://moef.gov.in

BT7CE6-60.2 DISASTER MANAGEMENT (Open Elective-II)

Credit 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	**INTRODUCTION:** Objective, scope and outcome of the course	1
2	Understanding Disaster: Concept of Disaster - Different approaches- Concept of Risk -Levels of Disasters - Disaster Phenomena and Events (Global, national and regional) Hazards and Vulnerabilities: Natural and man-made hazards; response time, frequency and forewarning levels of different hazards - Characteristics and damage potential or natural hazards; Types of disasters- floods, cyclones, lightening, thunderstorms, hailstorms, avalanches, droughts, cold and heat waves, epidemics, pest attacks, forest fire, chemical, industrial, radiological and nuclear disasters, building collapse, rural and urban fire, road and rail accidents etc.	8
3	Hazard assessment - Dimensions of vulnerability factors; vulnerability assessment -Vulnerability and disaster risk - Vulnerabilities to flood and earthquake hazards Disaster Management Mechanism: Concepts of risk management andcrisismanagements-DisasterManagementCycle- Response and Recovery - Development, Prevention, Mitigation and Preparedness - Planning for Relief	8
4	Capacity Building: Capacity Building: Concept - Structural and Non-structural Measures Capacity Assessment; Strengthening Capacity for Reducing Risk - Counter-Disaster Resources and their utility in Disaster Management - Legislative Support at the state and nationallevels	8
5	Coping with Disaster: Coping Strategies; alternative adjustment processes – Changing Concepts of disaster management - Industrial Safety Plan; Safety norms and survival kits -Mass media and disaster management	7
6	Planning for disaster management: Strategies for disaster management planning - Steps for formulating a disaster risk reduction plan - Disaster management Act and Policy in India - Organizational structure for disaster management in India - Preparation of state and district disaster management plan. Case studies: Natural and man-made disasters, preparedness and planning.	8
	Total	40

	Text / Reference Books:
1	D B N Murthy Disaster Management: Text & Case Studies, Deep & Deep Pvt. Ltd.
2	S L Goel, Encyclopedia of Disaster Management, Deep & Deep Pvt. Ltd.
3	G K Ghosh, Disaster Management, A P H Publishing Corporation.
4	Satish Modh, Citizen's Guide to Disaster Management Macmilan.
5	Manual on Disaster Management, National Disaster Management, Agency Govt of India.
6	Disaster Management by Mrinalini Pandey Wiley 2014.
7	Disaster Science and Management by T. Bhattacharya, McGraw Hill Education (India) Pvt Ltd Wiley 2015

BT8CE6-60.1 COMPOSITE MATERIALS (Open Elective - I)

Credit 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Basics of composites:** Definition, Classification, Metal matrix, polymer matrix and ceramic matrix composites. Fibres, Matrices, Properties of various type of fibres. Various types of matrix materials and their properties. Polymers, Properties of polymers like epoxy, polyester and phenolic. Applications of composites in Engineering	9
3.	**Elastic behaviour of composite Lamina-** Micromechanics and Macro-mechanics approach **Micromechanics:** Volume fraction, weight fraction, density of composites, Lamina, longitudinal elastic properties, Transverse elastic properties, In-Plane shear modulus, Poisson's ratio.	8
4.	**Elastic behaviour of composite Lamina-Macro-mechanics:** Stress-Strain relations, General Anisotropic materials, Especially Orthotropic material, Transversely Isotropic material, Isotropic material, Stress-StrainrelationsforaThinLamina. Thermaland moisture expansion of a lamina	8
5.	**Testing of Composites:** Mechanical testing of composites, Tensile testing, Compressive testing, Intra-Laminar shear testing, Fracture testing, Experimental characterization of mechanical and hygrothermal constants.	8
6.	**Failure and Maintenance of Composites:** Failure types in laminates, Damage to laminate structures, Quality control, Case Studies	6
	Total	40

	Text / Reference Books:
1	Mathews F. L. and Rawlings R. D., "Composite Materials: Engineering and Science", 1st Edition, Chapman and Hall, London, England, 1994.
2	Chawla K. K., "Composite materials", Second Edition, Springer – Verlag,1998.
3	Agarwal, B. D. and Broutman, Composites", John Wiley & Sons
4	Daniel, I. M. and Ishaai., O., "Engineering Mechanics of CompositeMaterials", , Oxford University Press.

BT8CE6-60.2: FIRE AND SAFETY ENGINEERING (Open Elective-II)

Credit 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course	1
2	**Basic concepts of Fire Engineering:** Classification of fire, causes of fire, detection, prevention, extinguishing methods, first aid, fire fighting equipments	4
3	**Fixed fire fighting installations using water:** Hydrant or fire water system, Classification of hydrant system, Sprinkling system, Major foam pourer system, Steam drenching system, Emulsification	4
4	Fixed fire fighting installations not using water: Complete CO_2floodingsystem,CompleteDCPsprayingsystem,CompleteHalon flooding system	4
5	**Fire Control Technology:** Hose, Types of hose, Characteristics, Rope, Lines, knots and ladders, Pumps, primers, tenders and water relays	4
6	**Hazardous materials/Chemicals:** their properties, transportation and storage, threshold limits of chemicals, limits of flammability, PPE's usage – respiratory and non-respiratory, handling and storage of high-pressure gas cylinders, work in confined places – risks and hazards	5
7	**Fire resistant construction:** General requirement, fire resistance rating of different materials, factors affecting means of escape and structural fire safety, compartmentation, smoke extractionsystems, fire separation wall	6
8	**Fire Safety Design of Buildings:** Aims, Principles, technical requirements, passive and active fire protection, Emergency and escape lighting, Fire detection and alarm systems, Signage, Fire-fighting shafts, Fire hydrants, Norms and standards as perNational Building Code	8
9	**Safety Management and legislation:** Functions of safety management, Factories Act 1948, Workmen compensation Act 1923	4
	Total	40

	Text / Reference Books:
1	Fire Protection and Prevention by Brendra Mohan San, UBS Publishers & Distributors Pvt Ltd. Edition: 1st Edition 2008
2	Hand Book of Fire Technology by R.S. Gupta, Orient Longman Publishers, 2nd Edition 2005
3	Hand Book of Fire and Explosion Protection Engineering by Dennis P Nolan, Crest Publishing House, 1st Edition 2007
4	National Building Code, Bureau of Indian Standards.

BT7CS6-60.1: Quality Management/ISO 9000

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	01
2	**Introduction to Quality Management**: Evolution of Quality Management, Concepts of Product and service Quality, Dimensions of Quality, Deming's, Juran's, Crosby's Quality Philosophy, Quality Cost	06
3	**Process Quality Improvement:** Introduction to process quality, Graphical and statistical techniques for process Quality Improvement Graphical tools for data representation, 7QC tools, Sampling, sampling distribution, and hypothesis Testing, Regression, control charts, process capability analysis, Measurement system analysis, Analysis of Variance(ANOVA), Design and analysis of experiment (DOE), Acceptance sampling pan, TQM	09
4	**Leadership,** Lean and JIT Q Quality Philosophy, Benchmarking, Process failure mode and effect analysis (PFMEA), Service Quality, Six sigma for process Improvement, ISO 9001 and QS 9000, Quality audit, Quality Circles.	09
5	**Product Quality Improvement:** Quality Function Deployment, Robust Design and Taguchi Method	08
6	**Design Failure** Mode and Effect Analysis, Product Reliability Analysis, Six sigma in product development	07
	Total	40

BT7CS6-60.2: Cyber Security

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	01
2	**Introduction to Cybercrime**: Introduction, Cybercrime, and Information Security, Defining Cybercriminals, Classifications of Cybercrimes. Cybercrime: The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes.	5
3	**Cybercrime**: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies an Measures in Mobile Computing Era, Laptops.	7
4	**Cyber Offenses**: How Criminals Plan Them: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector, Cloud Computing.	7
5	**Tools and Methods Used in Cybercrime**: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.	7
6	**Cyber Security**: Organizational Implications Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations.	07
7	**Management Perspective of Cyber Security (ISO27001):** Risk Assessment and Treatment, Security Policy, Organization of Information Security	06
	Total	40

TEXT BOOK:

1. Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Nina Godbole and Sunil Belapure, Wiley INDIA.

REFERENCE BOOK:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security , Chwan-Hwa(john) Wu,J.David Irwin.CRC Press T&F Group

BT8CS6-60.1: Big Data Analytics

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	01
2	**Introduction to Big Data:** Big data features and challenges, Problems with Traditional Large-Scale System, Sources of Big Data, 3 V's of Big Data, Types of Data. Working with Big Data: Google File System. Hadoop Distributed File System (HDFS) - Building blocks of Hadoop (Namenode. Data node. Secondary Namenode. Job Tracker. Task Tracker), Introducing and Configuring Hadoop cluster (Local. Pseudo-distributed mode, Fully Distributed mode). Configuring XML files.	10
3	**Writing MapReduce Programs:** A Weather Dataset. Understanding Hadoop API for MapReduce Framework (Old and New). Basic programs of Hadoop MapReduce: Driver code. Mapper code, Reducer code. Record Reader, Combiner,Partitioner.	08
4	**Hadoop I/O:** The Writable Interface. Writable Comparable and comparators. Writable Classes: Writable wrappers for Java primitives. Text. Bytes Writable. Null Writable, Object Writable and Generic Writable. Writable collections. Implementing a Custom Writable: Implementing a Raw Comparator for speed, Custom comparators.	08
5	**Pig:** Hadoop Programming Made Easier Admiring the Pig Architecture, Going with the Pig Latin Application Flow. Working through the ABCs of Pig Latin. Evaluating Local and Distributed Modes of Running Pig Scripts, Checking out the Pig Script Interfaces, Scripting with Pig Latin.	07
6	**Applying Structure to Hadoop Data with Hive:** Saying Hello to Hive, Seeing How the Hive is Put Together, Getting Started with Apache Hive. Examining the Hive Clients. Working with Hive Data Types. Creating and Managing Databases and Tables, Seeing How the Hive Data Manipulation Language Works, Querying and Analyzing Data.	06
	Total	40

BT8CS6-60.2: IPR, Copyright and Cyber Law of India

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	01
2	**Concept of Domain Names:** Server; Web Hosting; Protocols; E-Mail and Chat; Basics of Internet. Use of Internet in Legal Profession. Concept of Cyber Space: Definition and Meaning of Cyber Space. **Cyber Crimes:** Types of Cyber Crimes, Tempering with Computer Source Documents; Hacking with Computer System; Publishing of Obscene Information in Electronic Form; Breach of Confidentiality and Privacy; Publishing of False Digital Signature Certificate.	08
3	**Intellectual Property Rights:** Concepts and Evolution: Introduction to Intellectual Property Rights, Evolution of Intellectual Property Laws. Standards and Concepts in Intellectual Property, Conventions and Treaties Relating to Global Administration of Intellectual Property Rights, Protection and Classification Regional Conventions and Treaties, Organization, Jurisdiction enforcement and Administration of IPRs, IPRs and Information Technology IPRs and Bio- technology, IPRs and Traditional Knowledge, Management of Intellectual Property Rights, Law of Intellectual Property and Ethical Issues, Knowledge Driven Economy and IPR, Intellectual Property Rights in India and abroad.	08
4	**Law of Patents:** Introduction ,Evolution of patent Law, Scope and Purpose, Classification of Patents, Patent Law in India: Patent Act of 1970, The Patents (Amendments) Act, 2002, Patent Office and Authorities, Grant of Patent, Right and Obligation of a Patentee, Infringement of Patents, Offenses and penalties, Patents and other commercial Law, Patents – International Law, Patents. Law- Emerging Trends, Social Implication of Patents.	07
5	**Introduction to Copyrights as forms of Intellectual Property, Copyright Law in India (Copyright Act of 1957):** Meaning, Form of Copyright and Ownership Assignment/License, Registration and terms of Copyright, Copyright infringement , Offences, Remedies and Enforcement, Broad casting Organization and performers, Copyright – International Law, Introduction to trademarks, Trademarks – forms of Intellectual Property, Law of trade Marks in India (trademark act of 1999)-meaning, registration and Authorities, Right conferred by Registration and use of Trademarks, Infringement of Trademarks and passing off, Offences, remedies and enforcement, Trademarks –International Law	08
6	**Jurisdiction Issues in Cyber Space:** Concept of Jurisdiction; International Law and Jurisdiction in Cyber Space; Personal Jurisdiction in Cyber Space; Indian Perspective of Jurisdiction in Cyber Space. Cyber Law and Related Issues: Freedom of Speech and Expression in Cyber Space; Privacy Issues; Defamation in Cyber Space; Liabilities of Intermediaries. Conventions on Cyber Law: UNCITRAL Model Law on Electronic Commerce; Convention on Cyber crime; India and Cyber Crimes Conventions; United State of America and Cyber Crimes Conventions; United Kingdom and Cyber Crimes Conventions.	08
	Total	40

BT7EE6-60.1: ELECTRICAL MACHINES AND DRIVES

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	BASIC CONCEPTS IN ROTATING MACHINES and DC MOTORS: Introduction to magnetic circuits – Magnetically induced e.m.f and force – AC operation of magnetic circuits – Hysteresis and Eddy current losses. Energy in magnetic systems – Field energy & mechanical force -Constructional features of DC machine – Principle of operation of DC generator – EMF equation.	8
2	SINGLE PHASE & THREE PHASE INDUCTION MACHINES: Construction and principle of operation of single phase & three phase induction motor - Torque & Power equations – starting and speed control of induction machines - Slip – Torque characteristics.	8
3	REVIEW OF ELECTRIC DRIVES: Electric Drives-Advantage of Electric Drives-selection of Motor power rating- Thermal model of motor for heating and cooling - Classes of duty cycle- Determination of motor rating - control of Electric drives-modes of operation - speed control and drive classifications - closed loop control of drives.	6
4	SOLID STATE CONTROL OF DRIVES: DC motor and their performance-Braking - uncontrolled rectifier control - controlled rectifier fed DC drives - Chopper controlled DC drives - Time ratio control and current limit control - Single, two and four quadrant operations	8
5	SOLID STATE CONTROL OF INDUCTION MOTOR: Induction Motor Drives-Stator control-Stator voltage and frequency control – V/f control, AC Controller based speed control. cycloconverter fed induction motor drives – slip power recovery schematic control of rotor resistance using DC chopper.	8
	TOTAL	

TEXT BOOKS

1. Bose.B.K, "Power Electronics and Variable frequency drives", 1st ed, IEEE Press Standard Publications 2002.

2. Kothari.D.P and Nagrath.I.J. “Electrical Machines”, Tata McGraw Hill Publishing Co.Ltd, New Delhi, 5th edition 2002.

REFERENCES

1. Dr. Murugesh Kumar K. DC “Machines & Transformers”, Vikas Publishing House Pvt. Ltd., 2003.

2. Dubey. G.K, "Fundamentals of Electrical drives", Narora publications, 1995

3. Krishnan.R, "Electric motor drives Modeling, Analysis and Control", 1st edition, Pearson Publications, 2002.

BT7EE6-60.2: Power Generation Sources.

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	INTRODUCTION: World energy status, Current energy scenario in India, Environmental aspects of energy utilization, Environment - Economy - Energy and Sustainable Development, Energy planning.	4
2	Conventional Energy Generation Methods: Thermal Power plants: Basic schemes and working principle. Gas Power Plants: open cycle and closed cycle gas turbine plants, combined gas & steam plants-basic schemes. Hydro Power Plants: Classification of hydroelectric plants. Basic schemes of hydroelectric and pumped storage plants. Nuclear Power Plants: Nuclear fission and nuclear fusion. Fissile and fertile materials. Basic plant schemes with boiling water reactor, heavy water reactor and fast breeder reactor. Efficiencies of various power plants	8
3	SOLAR ENERGY: Basic concepts, Solar radiation – Measurement, Solar thermal systems – Flat plate and concentrating collectors, Solar passive space - Solar heating and cooling techniques – Solar desalination – Solar Pond - Solar cooker - Solar dryers-Solar furnaces - Solar pumping, Solar green house- Solar thermal electric power plant – Solar photo voltaic conversion – Solar cells – PV applications, Hybrid systems.	6
4	WIND ENERGY: Introduction-Availability- Wind power plants , Power from the wind, Wind energy conversion systems, site characteristics, Wind turbines types – Horizontal and vertical axis-design principles of wind turbine – Blade element theory, Magnus effect- Performance. Wind energy Applications – Hybrid systems, Wind energy storage, Safety and environmental aspects.	6
5	BIOMASS ENERGY: Biomass – usable forms- composition- fuel properties – applications, Biomass resources, Biomass conversion technologies - direction combustion - pyrolysis – gasification -anaerobic digestion, Bioethanol and Biodiesel Production - Economics - Recent developments.Energy farming, Biogas technology - Family biogas plants, Community and institutional biogas plants – design consideration – applications.	4
6	OTHER RENEWABLE ENERGY SOURCES: Tidal energy – Wave energy – Open and closed OTEC Cycles – Small hydro – Geothermal energy – Social and environmental aspects.Fuel cell technology - types, principle of operation – applications.Hydrogen energy production - Storage – transportation – utilization.	8
	TOTAL	

TEXT BOOKS

1. Godfrey Boyle, "Renewable Energy", Power for a Sustainable Future, Oxford University Press, U.K, 1996.
2. Twidell.J.W & Weir.A, "Renewable Energy Sources", EFN Spon Ltd., UK, 1986
3. Tiwari.G.N, "Solar Energy – Fundamentals Design", Modelling and applications, Narosa Publishing House, NewDelhi,2002

REFERENCES:

1. Freris.L.L, "Wind Energy Conversion systems", Prentice Hall, UK, 1990.
2. Veziroglu.T.N, "Alternative Energy Sources", Vol 5 and 6, McGraw-Hill, 1978
3. Johnson Gary.L, "Wind Energy Systems", Prentice Hall, New York, 1985.
4. "Energy planning in Developed countries (U.N.)", Oxford University Press, 1984.
5. G.D. Rai, "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 1999.
6. S.P. Sukhatme, "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997
7. "Renewable energy sources of conversion technology:N.K Bansal", Manfred Kleen Man and Michael Meliss, TMH Publication.
8. Kothari P, K C Singal and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Pvt. Ltd.,New Delhi, 2008

BT8EE6-60.1: Energy Audit and Demand side Management

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	**Energy Scenarios:** Energy Conservation, Energy Audit, Energy Scenarios, Energy Consumption, Energy Security, Energy Strategy, Clean Development Mechanism.	4
2	**Types of Energy Audits and Energy-Audit Methodology:** Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training.	4
3	**Survey Instrumentation:** Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data – Acquisition System, Thermal Basis.	4
4	**Electrical-Load Management:** Electrical Basics, Electrical Load Management, Variable-Frequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor, Transmission and Distribution Losses.	6
5	**Energy Audit of Motors:** Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling.	4
6	**Energy Audit of Lighting Systems:** Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities.	4
7	**Energy Audit Applied to Buildings:** Energy Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy Savings Tips Applicable to New as well as Existing Buildings.	4
8	**Demand side Management:** Scope of DSM, Evolution of DSM concept, DSM planning and Implementation, Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM, customer acceptance, implementation issues, Implementation strategies, DSM and Environment.	6
9	**Energy Conservation:** Motivation of energy conservation, Principles of Energy conservation, Energy conservation planning, Energy conservation in industries, EC in SSI, EC in electrical generation, transmission and distribution, EC in household and commercial sectors, EC in transport, EC in agriculture, EC legislation.	4
	TOTAL	

Text Books:

1. Handbook on Energy Audit Sonal Desai McGraw Hill 1st Edition, 2015
2. Generation of Electrical Energy B R Gupta S. Chand 1stEdition, 1983
3. Principles of Energy Conversion : A.W. Culp.
4. Energy Conversion systems : Begamudre, Rakoshdas
5. Direct Energy Conversion : W.R.Corliss
6. Energy Economics -A.V.Desai (Wieley Eastern)
7. Industrial Energy Conservation : D.A. Reay (Pergammon Press)
8. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991

Reference Books:

1. Energy Audit and Management, Volume-I, IECC Press
2. Energy Efficiency in Electrical Systems, Volume-II, IECC Press
3. Energy Management: W.R.Murphy, G.Mckay, Butterworths Scientific
4. Energy Management Principles, C.B.Smith, Pergamon Press 5. Industrial Energy Conservation, D.A. Reay, Pergammon Press
6. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Interscience
7. Industrial Energy Management and Utilization, L.C. Witte, P.S. Schmidt, D.R. Brown, Hemisphere Publication, Washington, 1988
8. Hand Book of Energy Audits, Albert Thumann, P.E., C.E.M. William J. Younger, C.E.M., CRC Press

BT8EE6-60.2: Soft Computing

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	INTRODUCTION TO SOFT COMPUTING: Aims of Soft Computing-Foundations of Fuzzy Sets Theory-Basic Concepts and Properties of Fuzzy Sets- Elements of Fuzzy Mathematics-Fuzzy Relations-Fuzzy Logic	6
2	APPLICATION OF FUZZY SETS: Applications of Fuzzy Sets-Fuzzy Modeling – Fuzzy Decision Making-Pattern Analysis and Classification-Fuzzy Control Systems-Fuzzy Information Processing- Fuzzy Robotics.	8
3	ARTIFICIAL NEURAL NETWORKS: Artificial Neural Networks-Models of Neuron-Architecture of Feed Forward Neural Networks, Recurrent Neural Networks-Learning methods-supervised and unsupervised learning-Time Delay Neural Networks-Radial Basis Function Neural Networks-Adaptive Resonance Theory (ART) Neural Networks- Associative Neural Memory Models-Application of ANN.	8
4	GENETIC ALGORITHMS: Main Operators- Genetic Algorithm Based Optimization-Principle of Genetic Algorithm- Genetic Algorithm with Directed Mutation-Comparison of Conventional and Genetic Search Algorithms-Issues of GA in practical implementation. Introduction to Particle swarm optimization-PSO operators-GA and PSO in engineering applications.	6
5	NEURO-FUZZY TECHNOLOGY: Fuzzy Neural Networks and their learning-Architecture of Neuro-Fuzzy Systems- Generation of Fuzzy Rules and membership functions - Fuzzification and Defuzzyfication in Neuro-Fuzzy Systems- Neuro-Fuzzy Identification - Neuro Fuzzy Control-Combination of Genetic Algorithm with Neural Networks-Combination of Genetic Algorithms and Fuzzy Logic-Neuro-Fuzzy and Genetic Approach in engineering applications.	6
6	PROGRAMMING USING MATLAB: Using Neural Network toolbox – Using Fuzzy Logic toolbox- Using Genetic Algorithm & directed search toolbox.	6
	TOTAL	

TEXT BOOKS:

1. Sivanandam.S.N, Deepa.S.N, “Principles of soft computing”,2nd Edition, Wiley India Pvt Limited, 2011.
2. Juh Shing Roger Jang, Cheun Tsai Sun, Eiji Mizutani, “Neuro fuzzy and soft computing”, Prentice Hall, 1997.

REFERENCES:

1. Aliev,R.A, Aliev,R.R, “Soft Computing and its Application”, World Scientific Publishing Co. Pvt. Ltd., 2001.
2. Mehrotra.K, Mohan.C.K, Ranka.S, “Elements of Artificial Neural Networks”, The MIT Press, 1997.
3. Juh Shing Roger Jang,Cheun Tsai Sun,Eiji Mizutani, “Neuro fuzzy and soft computing”, Prentice Hall, 1997.
4. Ronald R.Yager, Lofti Zadeh, “An Introduction to fuzzy logic applications in intelligent Systems”, Kluwer Academic, 1992.
5. Cordón.O, Herrera.F, Hoffman.F, Magdalena.L “Genetic Fuzzy systems”, World Scientific Publishing Co. Pvt. Ltd., 2001.

BT7EC6.60.1: Principle of Electronic Communication (OPEN ELECTIVE)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	01
2	**Introduction:** Need for Modulation, Frequency translation, Electromagnetic spectrum, Gain, Attenuation and decibels. **Simple description on Modulation:** Analog Modulation-AM, Frequency modulation-FM, Pulse Modulation-PAM, PWM, PCM, Digital Modulation Techniques-ASK, FSK, PSK, QPSK modulation and demodulation schemes.	10
3	**Telecommunication Systems:** Telephones Telephone system, Paging systems, Internet, Telephony. **Networking and Local Area Networks:** Network fundamentals, LAN hardware, Ethernet LANs, Token Ring LAN.	09
4	**Satellite Communication:** Satellite Orbits, satellite communication systems, satellite subsystems, Ground Stations Satellite Applications, Global Positioning systems. **Optical Communication:** Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.	10
5	**Cellular and Mobile Communications:** Cellular telephone systems, AMPS, GSM, CDMA and WCDMA. **Wireless Technologies:** Wireless LAN, PANs and Bluetooth, Zig Bee and Mesh Wireless networks, Wimax and MANs, Infrared wireless, RFID communication, UWB.	10
	Total	40

Text/Reference Books:	
1.	Principles of Electronic Communication Systems, Louis E. Frenzel, 3e, McGraw Hill publications, 2008.
2.	Electronic Communications systems, Kennedy, Davis 4e, MC GRAW HILL EDUCATION, 1999
3.	Theodore Rapp port, Wireless Communications - Principles and practice, Prentice Hall, 2002.
4.	Haykin S., "Communications Systems", John Wiley and Sons, 2001.
5.	Roger L. Freeman, Fundamentals of Telecommunications, 2e, Wiley publications.
6.	Introduction to data communications and networking, Wayne Tomasi, Pearson Education, 2005.
7.	Taub H. and Schilling D.L, "Principles of Communication Systems" Tata McGraw Hill, 2001

BT7EC6.60.2: Micro and Smart System Technology (OPEN ELECTIVE)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	**INTRODUCTION TO MICRO AND SMART SYSTEMS: (**a) Smart-material systems- History, Introduction and evolution of smart materials, structures and systems. Components of a smart system. Application areas. Commercial products. (b) Microsystems- Introduction, History and their evolution, Feynman's vision. Micromachined transducers. Evolution of micro-manufacturing. Multi-disciplinary aspects. Applications areas. Commercial products.	08
3	**MICRO AND SMART DEVICES AND SYSTEMS: PRINCIPLES AND MATERIALS:** a) Definitions and salient features of sensors, actuators, and systems. b) Sensors: silicon capacitive accelerometer, piezo-resistive pressure sensor, blood analyzer, conductometric gas sensor, fiber-optic gyroscope and surface-acoustic-wave based wireless strain sensor. c) Actuators: silicon micro-mirror arrays, piezo-electric based inkjet print head, electrostatic comb-drive and micromotor, magnetic micro relay, shape memory-alloy based actuator, electro-thermal actuator. d) Systems: micro gas turbine, portable clinical analyzer, active noise control in a helicopter cabin.	05
4	**MICROMANUFACTURING AND MATERIAL PROCESSING:** a. Silicon wafer processing, lithography, thin-film deposition, etching (wet and dry), wafer-bonding, and metallization. b. Silicon micromachining: surface, bulk, moulding, bonding based process flows. c. Thick-film processing: d. Smart material processing: e. Processing of other materials: ceramics, polymers and metals f. Emerging trends.	10
5	**MODELING:** a. Scaling issues. b. Elastic deformation and stress analysis of beams and plates. Residual stresses and stress gradients. Thermal loading. Heat transfer issues. Basic fluids issues. c. Electrostatics. Coupled electromechanics. Electromagnetic actuation. Capillary electro-phoresis. Piezoresistive modeling. Piezoelectric modeling. Magnetostrictive actuators.	08

6	**INTEGRATION AND PACKAGING OF MICROELECTRO MECHANICAL SYSTEMS:** Integration of microelectronics and micro devices at wafer and chip levels. Microelectronic packaging: wire and ball bonding, flip-chip. Low temperature-cofired-ceramic (LTCC) multi-chip-module technology. Microsystem packaging examples. Examples from smart systems and micromachined accelerometer or a thermal cycler BEL pressure sensor, thermal cycler for DNA amplification, and active vibration control of a beam	**08**
	Total	**40**

Text/Reference Books:	
1.	**MEMS & Microsystems: Design and Manufacture,** Tai-Ran Tsu,Tata Mc- Graw-Hill.
2.	**"Micro and Smart Systems"** by Dr. A.K.Aatre, Prof. Ananth Suresh, Prof.K.J.Vinoy, Prof. S. Gopalakrishna,, Prof.K.N.Bhat., John Wiley Publications.
3.	**Microsystems Design,** S. D. Senturia, 2001, Kluwer Academic Publishers, Boston, USA. ISBN 0-7923-7246-8.
4.	**Analysis and Design Principles of MEMS Devices,** Minhang Bao, Elsevier, Amsterdam, The Netherlands, ISBN 0-444-51616-6.
5.	**Design and Development Methodologies,** Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Gopalakrishnan, Wiley.
6.	**MEMS**- Nitaigour Premchand Mahalik, The Mc-GrawHill 2007.

BT8EC6.60.1: Industrial and Medical applications of RF Energy (OPEN ELECTIVE)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	**Fundamental concepts**: electromagnetic(EM) spectrum, ISM band, Maxwell's laws for EM field, EM wave, propagation reflection and transmission, skin depth, VSWR, impedance matching, microwave (MW) components, waveguide resonators, MW sources	08
3	**RF Heating**: Complex dielectric constant, dipolar loss mechanism, interfacial loss, combined effects, variation of Complex dielectric constant ε" with moisture content, temperature, frequency and composition, magnetic loss factor, specific heat, rate of rise of temperature.	07
4	**Applicators:** travelling wave applicators: Axial wave applicators, meander travelling wave applicators, standing wave and attenuation in meander travelling wave applicators, multi mode oven applicators: theoretical aspects, field distribution and uniform heating, stirrers, choice of wall materials, door and door seals.	08
5	**Industrial applications:** application in rubber, leather & textiles, plastics, pharmaceuticals, tobacco drying , Microwave vulcanization, treatment of elastomers. **Application in food industry**: cooking mechanism, animal products, vegetables products, thawing and tempering, drying, preservation, advantages of Microwave processing	08
6	**Biological and medical applications**: Interaction with organism, basic interaction with cell membrane, thermal interaction with living organism, biological effects on cells and micro-organism, blood immune system, nervous system, endocrine system, thermal regulation and metabolism, hyperthermia in cancer treatment, clinical applications. **Hazards and safety standards**: exposure standards, emission standards, leakage from industrial equipments, mobile handsets, mobile towers, safety precautions.	08
	Total	40

Text/Reference Books:	
1.	D M Pozar, Microwave Engineering, John Wiley.
2.	R C Metaxas, Engineers handbook for industrial Microwave heating, IET publications
3.	R C Metaxas, R J Meredith, Industrial Microwave heating, peter peregrims.
4.	Jacaques thury, Microwave industrial, scientific and medical applications, Arctech house.
5.	G Roussy J A Pearce, foundations of industrial applications of Microwave and radio frequency field: physical and chemical process, wiley.

BT8EC6.60.2: Robotics and Control (OPEN ELECTIVE)

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	**Introduction to control problem**- Industrial Control examples. Transfer function. System response. Control hardware and their models: potentiometers, synchros, LVDT, dc and ac servomotors, tacho-generators, electro hydraulic valves, hydraulic servomotors, electro pneumatic valves, pneumatic actuators. Closed-loop systems. Block diagram and signal flow graph analysis. Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. proportional, integral and derivative systems. Feedforward and multi-loop control configurations, stability concept, relative stability, Routh stability criterion	08
3	**Time response of second-order systems**- steady-state errors and error constants. Performance specifications in time-domain. Lead and lag compensation. **Frequency-response analysis**- Polar plots, Bode plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion. Performance specifications in frequency-domain.. Lead and Lag compensation.	07
4	**ROBOT ARM KINEMATICS:** Introduction, The direct Kinematics Problem, Rotation Matrices, Composite Rotation Matrix, Rotation matrix about an arbitrary axis, Rotation matrix with Euler angle representation, Geometric interpretation of Homogeneous transformation matrices, composite homogeneous transformation matrix, Links joints and their parameters. The Denavit Hartenberg representation. Kinematic equations for manipulators, Other specifications of the locations of the End-Effector, Classification of Manipulators, The inverse Kinematics problem, Inverse Transform Technique for Euler Angles Solution	08
5	Planning of Manipulator Trajectories: Introduction, General considerations on Trajectory planning, joint-interpolated Trajectories, calculation of a 4-3-4 Joint trajectory, Cubic Spline Trajectory. Sensing: Range sensing, Triangulation, Structured Lighting Approach, Time-of-Flight range finders.	06
6	Proximity sensing, Inductive sensors, Hall effect sensors, Capacitive Sensors, Ultrasonic sensors, Optical Proximity Sensors, Touch sensors, Binary sensors, Analog sensors, Force and Torque sensing, Elements of a Wrist sensor. **LOW-LEVEL VISION:** Image acquisition, illumination Techniques, imaging geometry, some basic transformations, perspective transformations. **Higher-Level Vision**: Segmentation, Edge Linking and Boundary detection,	06

7	Camera model, camera calibration, stereo imaging, some basic relationships between pixels, Neighbours of a Pixel, connectivity, distance measures, Preprocessing, Spatial-Domain methods, Frequency-Domain methods, Smoothing, Enhancement, Edge detection, Thresholding. Thresholding. Region-oriented segmentation, the use of motion, description, Boundary descriptors, Regional descriptors.	**04**
	Total	**40**

Text/Reference Books:	
1.	Robotics control sensing Vision and Intelligence- K.S.Fu, R.C. Gonzalez, C.S.G. Lee, McGraw Hill, 1987.
2.	Ogata, K., "Modern Control Engineering", Prentice Hall, second edition, 1991.
3.	Introduction to Robotics Mechanics and control– John J. Craig, 2nd Edition, Pearson education, 2003.
4.	Nagrath&Gopal, "Modern Control Engineering", New Age International, New Delhi
5.	James G.Keramas, "Robot Technology Fundamentals" , Cengage learning

BT7ME6-60.1: Finite Element Analysis

Credit:3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1.	**Introduction:** Objective, scope and outcome of the course.	1
2.	Introduction to FEM, Application of FEM, Advantages of FEM, FEA Softwares.	2
3.	**Steps of FEM:** Discretization, Local stiffness matrix, coordinate transformation, Assembly, Global stiffness matrix, imposition of Boundary conditions, Properties of stiffness matrix, Banded symmetric matrix and bandwidth.	5
4.	**One-dimensional Finite Element Analysis:** Basics of structural mechanics, stress and strain tensor, constitutive relation, Principle of minimum Potential, Finite element model concept, Derivation of finite elements equations using potential energy approach for linear and quadratic 1-D bar element.	5
5.	Shape functions and their properties, Assembly, Boundary conditions, Computation of stress and strain, Problems on 1-D structural analysis.	4
6.	**Two Dimensional Finite Element Analysis:** Finite element formulation using three nodded triangular (CST) element , Plane stress and Plane strain problems,	5
7.	Shape functions, node numbering and connectivity, Assembly, Boundary conditions, Problems on 2-D structural analysis.	4
8.	Finite Element Formulation from Governing Differential Equation: Galerkin FEM method,	5
9.	Application to one dimensional structural problems, one-dimensional heat transfer problems, etc., Introduction to variational formulation (Ritz Method.)	4
10.	**Higher Order Elements:** Lagrange's interpolation formula for shape functions, Convergence of solution, static condensation, p and h methods of mesh refinement, Aspect ratio.	5
	Total	40

TEXT BOOK	
1	Seshu P., Text Book of Finite Element Analysis, Prentice Hall India
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Dixit, U. S., Finite Element Methods for Engineers, Cengage Learning
2	Bathe K.J., Finite Element Procedure in Engineering Analysis, Prentice Hall India.
3	Reddy J.N., An Introduction to the Finite Element Method, Tata McGraw-Hill.
4	Cook and Plesha, Concepts & Applications of Finite Element Analysis, Willey India.
5	Chandrupatla and Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall India.

BT7ME6-60.2: Quality Management

Credit:3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction to Quality Management**: Quality – Concept, Different Definitions and Dimensions, Inspection, Quality Control, Quality Assurance and Quality Management, Quality as Wining Strategy, Views of different Quality Gurus, Quality Cost.	6
3	**Process Quality Improvement:** Introduction to process quality, Graphical and statistical techniques for process Quality Improvement, Graphical tools for data representation, 7QC tools, Sampling, sampling distribution, and hypothesis Testing, Regression, control charts, process capability analysis, Measurement system analysis, Analysis of Variance(ANOVA), Design and analysis of experiment (DOE), Acceptance sampling pan, TQM	9
4	**Leadership,** Lean and JIT Q Quality Philosophy, Benchmarking, Process failure mode and effect analysis (PFMEA), Service Quality, Six sigma for process Improvement, ISO 9001, ISO 14000 and QS 9000, Quality audit, Quality Circles.	9
5	**Product Quality Improvement:** Quality Function Deployment, Robust Design and Taguchi Method	8
6	**Design Failure:** Mode and Effect Analysis, Product Reliability Analysis, Six sigma in product development	7
	Total	40

TEXT BOOK	
1	Fundamentals of Quality Control and Improvement, Amitava Mitra, Prentice Hall
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Introduction to Statistical Quality Control, Douglas C. Montgomery, Wiley.
2	Quality Planning and Analysis, J.M.Juran and F.M. Gryna, McGraw Hill
3	Quality Control, Dale H. Besterfield, Pearson/Prentice Hall
4	Statistical Quality Control, E. L. Grant and Richard S. Leavenworth, Tata McGraw-Hill
5	Design and Analysis of Experiments, Douglas C. Montgomery, Wiley-India

BT8ME6-60.1: Operations Research

Credit:3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Overview of Operations Research**	1
3	**Linear Programming**: Applications and model formulation, Graphical method, Simplex method, duality and Sensitivity analysis.	4
4	Transportation Model and Assignment Model including travelling salesman problem.	4
5	**Integer Linear Programming:** Enumeration and cutting Plane solution concept, Gomory's all integer cutting plane method, Branch and Bound Algorithms, applications of zero-one integer programming.	5
6	**Replacement Models:** Capital equipment replacement with time, group replacement of items subjected to total failure.	3
7	**Queuing Theory**: Analysis of the following queues with Poisson pattern of arrival and exponentially distributed service times, Single channel queue with infinite customer population, Multichannel queue with infinite customer population,	3
8	**Competitive Situations and Solutions**: Game theory, two person zero sum game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy, approximate solution, and simplified analysis for other competitive situations. Application of linear programming	4
9	Theory of Decision making: Decision making under certainty, risk and uncertainty. Decision trees.	3
10	**Deterministic Inventory control models:** functional role of inventory, inventory costs, model building, Single item inventory control model without shortages, with shortage and quantity discount. Inventory control model with uncertain demand, service level, safety stock, P and Q systems, two bin system. Single period model. Selective Inventory control techniques.	4
11	**Probabilistic Inventory control models:** Instantaneous demand without setup cost and with setup cost, Continuous demand without setup cost	4
12	**Simulation**: Need of simulation, advantages and disadvantages of simulation method of simulation. Generation of Random numbers, Generation of Normal Random numbers. Use of random numbers for system simulation. , Monte Carlo simulation, simulation language ARENA, Application of simulation for solving queuing Inventory Maintenance, Scheduling and other industrial problems	4
	Total	40

TEXT BOOK	
1	Operations Research, Ravindran, Phillips and Solberg, Wiley India.
2	Operations Research, Gupta and Heera, S. Chand Publications.
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Introduction to Operations Research, Hillier F.S. and Lieberman G.J., CBS Publishers.
2	Operations Research, Taha H.A., Pearson Education
3	Linear Programming and Network Flows, Bazaraa, Jarvis and Sherali, Wiley India.
4	Principles of Operations Research, Wagner H.M., Prentice Hall of India.

BT8ME6-60.2: Simulation Modeling and Analysis

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	**Physical modeling :** Concept of system and environment, continuous and discrete system, linear and nonlinear system, stochastic activities, static and dynamic models, principles used in modeling, Basic simulation modeling,	4
	Role of simulation in model evaluation and studies, Advantages and Disadvantages of simulation. Modeling of Systems, iconic analog. Mathematical Modeling	3
2	**Computer system simulation:** Technique of simulation, Monte Carlo method, experimental nature of simulation, numerical computation techniques, continuous system models, analog and hybrid simulation, feedback systems	4
	Buildings simulation models of waiting line system, Job shop, material handling and flexible manufacturing systems	4
3	**Probability concepts in simulation:** Stochastic variables, discrete and continuous probability functions mainly Normal, lognormal, Weibull, exponential, Uniform, Poisson, Binomial, Triangular,	4
	Random Numbers: Properties, Generations methods, Tests for Random number- Frequency test, Runs test, Autocorrelation test. **Random Variate Generation:** Inverse Transform Technique- Exponential, Uniform, Weibull, Triangular distributions, Direct transformation for Normal and log normal Distributions,	5
4	**Input Modelling**: Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series	4
	Verification and validation: Design of simulation experiments, validation of experimental models, testing and analysis.	3
5	**Output Analysis – Types of Simulations with Respect to Output Analysis,** Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state	4
	Selection of Simulation Software, Simulation packages, Trend in Simulation. Do modeling using ARENA software which is freely available. Some more s**uggested simulation packages are** Promodel, Quest, Witness, Extend, Simio etc. Students can learn	5
	TOTAL	**40**

TEXT BOOK	
1	Simulation Modeling and Analysis, Law A.M., McGraw Hill.
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Discrete-Event System Simulation, Banks and Carsan, Prentice Hall of India
2	Simulation Modeling and Analysis with ARENA, Altiok and Melamed, Academic Press
3	Simulation with ARENA, Keltan, Sadowski and Turrock, McGraw Hill
4	Simulation Modeling and ARENA, Rossetti and Taha, John Wiley and Sons
5	Systems Simulation with Digital Computer, Narsingh Deo, PHI Publication (EEE)

BT7MI6-60.1: Rock Engineering

Credit : 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam : 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Slope design: Basics mechanics of rock and spoil slope failures; Parameters for stability analysis;	4
3	Design of slopes; Reinforcement of rock slopes and monitoring of slopes	4
4	Design of mine excavations like drifts, shafts and stopes; Pillar design; Theories of roof failures of small and large excavations;	4
5	Cavability of ore and stratified deposit	3
6	Drillability of rocks; Mechanics of rotary and percussive drilling; Design of drills; Drill bits for optimum penetration;	4
7	Parameters affecting rate of penetration; Effect of flushing medium on drill performance	4
8	Rock reinforcement; Estimation of support requirements of underground excavation.	4
9	Mining subsidence, bumps and rock burst, istressing to control rock bursts	4
10	Mechanics of rock breakage in blasting;	4
11	Influence of rock properties; Controlling damage	3
	Total	39

BT7MI6-60.2: Mineral Processing

Credit : 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam : 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Scope, object and limitations of Mineral Dressing; Role of microscopic study	4
3	Communition and Liberation: Theory and practice of crushing & grinding; Conventional units used-their fields of application and limitation	4
4	Sizing and Classification: Laws of setting of solids in fluid; Laboratory methods of sizing and interpretation of sizing data;	4
5	Industrial sizing by screens; Types of classifiers; Classification as means of sizing by screens	3
6	Gravity concentration Methods- Jigging, Flowing film concentration like spirals and shaking table, Heavy Media separation; Theory, applications and limitations of each method;	3
7	Introductory Froth Flotation, physico-chemical, principles underlying flotation-reagents, flotation machines; Flotation of sulphides, oxides and non-metals	4
8	Electrical Methods of Concentration: Electrostatic and magnetic methods, their principles of operation, fields of application and limitations	3
9	Dewatering and drying: Thickening, filtration and drying	3
10	Coal washing: coal washability, crushing, sizing and cleaning of coal	3
11	Sampling: Importance and methods used in ore-dressing	3
12	Simplified Flow Sheets: Beneficiation of coal and simple ores of copper, lead, zinc, Iron and manganese with reference to Indian deposits	4
	Total	39

BT8MI6-60.1: Experimental Stress Analysis

Credit : 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam : 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Importance of experimental methods, similitude laws and design of experiments, some simple measuring instruments	8
3	Bagg's deformeter. Strain gauges-principles and applications	7
4	Mechanical, optical and electrical strain gauges; semi-conductor strain guages; strain recording instruments	8
5	Photo-elasticity-two dimensional stress analysis, principles and applications, Moirs techniques, three dimensional stress analysis	8
6	Non-destructive testing, Brittle coatings. Some application of experimental stress analysis and research, design and field problems	7
	Total	39

BT8MI6-60.2: Maintenance Management

Credit : 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam : 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Introduction: General objectives, Functions; Organization and administration of maintenance systems; Requirements, Concepts and structure of suitable organizations for maintenance systems	4
3	Failure Analysis: Analysis for source identification, classification land selectivity of failure; Statistical and reliability concepts and models for failure analysis	4
4	Classification of maintenance systems; Basis and models for various maintenance systems	4
5	Cost management for maintenance: cost estimates- recording, summarizing and distributing cost data, maintenance budget	4
6	Decision models for maintenance planning; Operation and control, optimum level of maintenance; replacement aspects of breakdown and preventive types, group and individual types, obsolete facility, deteriorating and completely failing facilities	4
7	Replacement vs. reconditioning, economics of overhaul, addition replacement model-additive damage case, zero memory case, partially observed situation, planning horizon procedure	3
8	Spare planning and control: static spares, insurance spares with and without salvage value, low moving spares; man power planning-crew size , allocation etc. stand by machines	4
9	economical and operational aspects; scheduling planning of activities, monitoring and updating, resource allocation, Assigning priorities	4
10	Other relevant topics: work measurement for maintenance, maintenance control indices, maintenance service contract, preventive maintenance management-guidelines, procedure, general management of lubrication system,	4
11	Organizing preventive maintenance program using vibration signature analysis-some basic ideas, management of records for maintenance, computerization of maintenance activities, major plant shut-down procedures	3
	Total	39

BT7PE6-60.1: Pipeline Engineering

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	Theory and different formulae of the flow of fluids in oil/gas pipelines; basic equations for the flow of fluids through pipes; different flow equations for laminar and turbulent flow of compressible and incompressible fluids. Introduction to the flow of Non- Newtonian fluids through pipes; multiphase flow and loop pipelines.	10
3	Components of Pipelines: Pipes, valves, flanges and fittings; Installation of expansion loops and thermodymetric tapping plant. Pigging: pigging technology, pig launcher and receiver, intelligent pigging, types of pigs.	10
4	Design of Pipeline: Piping materials and selection, Stress analysis in pipeline, Factors influencing oil, gas and refined products as pipeline design. Hydraulic surge and water hammer; specific heat of liquids; river crossing; pipe size and station spacing etc., various codes used in designing the pipeline. Offshore Pipeline: design and control of Sag and Over bend; description of stinger and riser. Articulated stinger, construction of offshore pipeline; method of underwater welding.	10
5	Prevention of hydrates, wax & scales. Crude conditioning and use of additives to improve flow conditions. Corrosion protection and control; design of cathodic protection system, pipeline automation.	9
	Total	40

BT7PE6-60.2: Water Pollution Control Engineering

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	Introduction: Characterisation and monitoring of industrial and municipal waste water, recycling and reuse of wastewater. Basic philosophy and selection of water pollution treatment plants; Design criteria: hydraulic loading rate, organic loading rate, residence time, dilution rate.	10
3	Physico-Chemical Treatment Methods: Sedimentation, coagulation, flocculation, thickening, floatation. Biological Treatment Fundamentals: Microbial metabolism, bacterial growth kinetics; Biological nitrification, denitrification and phosphorus removal; Anerobic fermentation and aerobic treatment.	10
4	Aerobic Suspended and Attached Growth Biological Treatment Processes: Aerated lagoon, activated sludge systems, trickling filter, sequential batch reactor, fluidized bed bioreactors. Anaerobic Suspended and Attached Growth Biological Treatment Processes: UASB and hybrid UASB reactors, bio-towers.	10
5	Advanced Treatment Processes: Membrane processes- reverse osmosis, ultrafiltration, nanofiltration and electrodialysis; Wet air oxidation, adsorption and ion-exchange; Wet-land and root-zone treatment of industrial and municipal wastes; Design of sludge drying beds, thermal and biological processes for sludge and land fillings. Case Studies: Waste water treatment and disposal strategies in petroleum, petrochemical, fertilizer, distillery, pulp and paper industries.	9
	Total	40

BT8PE6-60.1: Unconventional Hydrocarbon Resources

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	01
2	**CBM .** Formation and properties of coalbed methane: Generation of coalbed methane gas & its properties, properties of coal as reservoir rock & accumulation. Geological and petrographic influences on coal, Pore geometry, Micropore, Mesopore and macropore, cleat system Thermodynamics of coalbed methane: Sorption – principles, sorption isotherms – types and interpretation. CO_2, CH_4 and N_2 adsorption – desorption, hysteresis, Langmuir isotherm, Swelling of coal matrix isotherm construction.CH_4 content determination in coal seams. Underground coal gasification, carbon dioxide sequestration	12
3	**Overview of Drilling and Production systems of coalbed methane wells:** Selection of Artificial lift for CBM wells. Hydro-fracturing of coal seams. Treating and disposing produced water. Testing of coalbed methane wells.	7
4	**GAS HYDRATE:** Present status of gas hydrates. Formation, accumulation and properties of gas hydrates. Thermodynamics, kinetics and phase behaviour of gas hydrates. Types of gas hydrate. Geological and geophysical exploration of gas hydrate. Drilling and production systems of gas hydrate wells. Prevention & control of gas hydrates. Gas extraction from gas hydrates. Uses and application of gas hydrates	10
5	**SHALE GAS/ OIL:** Global Scenario of shale gas/ Oil production. Nature, origin and distribution of Shale Gas/ Oil. Characterization of Shale for Production of Shale Gas/ Oil. Extraction methods of Shale gas/ Oil: development of current practices. Location and size of production areas: estimated reserves and economics. Environmental issues in shale gas exploration. Markets and Globus impact on energy scenario. Economic factor of shale Gas/ oil production	10
	Total	40

BT8PE6-60.2: Energy Management & Policy

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	01
2	**Marketing policy for oil & Gas**: Markets for oil, gas, coal, electricity and renewable energy, resources and alternate fuels. Legal and policy aspects of supply and trading in energy.	10
3	**Regulations of energy industries**: Industry privatization. International context of liberalization of energy markets. Land acquisition policy, Carbon credit.	10
4	**Modeling techniques for supply and demand**: market structure, transportation models, game theory, futures markets, environmental issues, energy policy, energy regulation, input/output models.	10
5	Linear and nonlinear programming models, energy conservation, and dynamic optimization. Development of appropriate models and their application to current issues in energy markets. Energy audit.	9
	Total	40

BT7TT6-60.1: TECHNICAL TEXTILES

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction**: Objective, scope and outcome of the course.	1
2	**Introduction** Definition ,Textile materials in technical applications **Fibers** Natural and man-made fibers suitable for technical application and their relevant properties	7
3	**Medical Textiles** Fibers in various medical applications, Classification of medical Textiles ,Textile materials used for medical applications such as absorbency, sterilization, grafts, wound care, Cardiovascular application, Sutures. **Filtrations** Basic principles of wet and dry filtrations, Characteristic properties of fibres and fabrics in selective example of filtration.	12
4	**Protective Clothing** Thermal protection, Ballistic protection, Protection against micro organisms, chemicals and pesticides. Protection from electromagnetic radiation and static hazards	6
5	**Automotive Textiles** Fibers used for automotive applications – upholstery, carpeting, pre-formed parts, type, safety devices, filters and engine compartment items Brief description for the manufacture and application of these devices or parts **Textile Reinforced Composite Materials** – Introduction to composite materials – Textile reinforcement – Applications of composites.	6
6	**Textiles in Defence** – Introduction, Historical Background – Criteria for modern military textiles materials – various application of Textiles in various areas of defence such as environmental protection, thermal insulation, water proof water vapour permeable materials.	8
	Total	40

BT7TT6-60.2: GARMENT MANUFACTURING TECHNOLOGY

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Concept of comfort factors involved in the study of clothing Selection Criteria for a Garment	5
3	**Technology of Cutting Room** Planning, drawing and reproduction of the marker Requirements & Methods of marker-planning Spreading Requirements & Methods of Spreading Objectives and methods of cutting. Requirements of cutting. Nature of fabric packages	10
4	**Sewing** Seam types, properties & uses of seams, Stitch types, formation of stitches & their uses. Sewing defects.	5
5	**Alternative Methods of Joining Materials** Fusing, Welding & Adhesives, Moulding Pressing Purpose of pressing, pressing equipment and methods	10
6	Objective hand evaluation and tailorability assessment of the fabric Brief introduction to garment processing	9
	Total	40

BT8TT6-60.1: MATERIAL AND HUMAN RESOURCE MANAGEMENT

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Capital Structure: Meaning: Essentials of an ideal/optimum Capital Structure, Difference between capital, Capitalisation and Capital Structure.	7
3	Management of Working Capital: Definition; Nature Classification of Working Capital – (i) Permanent working Capital and (ii) Variable Working Capital; Factors affecting requirement of working capital.	8
4	Personal Management and HRD. Job Analysis: Meaning and Importance; Processes of Job Analysis. Job Description and Job Specification.	8
5	Materials Management: Definition and Objectives: Inventory Management.	8
6	Inventory Control: Techniques of Inventory control- ROL, FOR Value Analysis, ABC Analysis, VED Analysis; Factors affecting Inventory Control, Ordering Costs, Carrying	8
	Total	40

BT8TT6-60.2 : DISASTER MANAGEMENT

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Understanding Disasters and Hazards and related issues social and environmental. Risk and Vulnerability. Types of Disasters, their occurrence/ causes, impact and preventive measures:	12
3	Natural. Disasters- Hydro-meteorological Based Disasters like Flood, Flash Flood, Cloud Burst, Drought, Cyclone, Forest Fires; Geological Based Disasters like Earthquake, Tsunami, Landslides, Volcanic Eruptions.	12
4	Man made Disasters: Textile Processing Industrial Hazards, Major Power Break Downs, Traffic Accidents, Fire Hazards.	12
5	Management roll in mitigating Disaster in Indian Textile Industries. Roll of production people in Disaster Management.	3
	Total	40