

B.TECH ENERGY

The energy policy of any country is largely defined by the country's burgeoning energy deficit and increased focus on developing alternative sources of energy, particularly nuclear, solar and wind energy. The program aims to train students to serve as the technical focal point for energy development, for promoting and accelerating the pace of utilization of various energies.

Eligibility Criteria: 10+2(PCM) or equivalent in any stream

To earn a B.Tech Energy degree, a student has to earn a minimum of 180 credits. Minimum 100 credits to be earned from science subjects, 40 credits from Energy specialization and remaining can be taken from any stream

Every student has to attain a minimum of D grade in all courses; a student may however, and repeat or change any course being offered. Notwithstanding, every student must acquire the desired number of credits. The detailed course structure under different categories is given in succeeding pages. Brief description of the course content follows thereafter.

Codes	Subjects	Credit
31.101	Physics I	4
31.102	Engg. Chemistry I	4
31.103	Mathematics I	4
31.104	Environment & Ecology	4
31.105	Engg. Graphics	4
31.106	Physics II	4
31.107	Engg. Chemistry II	4
31.108	Mathematics II	4
31.109	Basic Electrical & Electronics Engg.	4
31.110	Basic Civil & Mech	4
31.111	Maths III	4
31.112	Elements of Fluid Mechanics	4
31.201	Network Analysis & Synthesis	4
31.202	Electromechanical Energy Conversion	4
31.203	Analog & Digital Electronics	4
31.204	Thermodynamics	4
31.205	Maths IV	4
31.206	Applied Mechanics & Materials	4
31.207	Engineering Economics & Business Organisation	4
31.208	Energy Conversion Systems	4
31.209	Conventional Energy Generation	4
31.210	Power Electronics	4
31.211	Industrial Management	4
31.212	Energy in Buildings	4
31.213	New & Renewable Energy Resources	4
31.301	Microprocessors & Applications	4
31.302	Transmission & Distribution Systems	4
31.303	Instrumentation & Control	4
31.304	Solar Energy Systems	4
31.305	Wind Energy Systems	4
31.306	Energy Conservation & Audit	4
31.307	Energy & Environmental Economics	4
31.308	Energy Modeling	4
31.309	Bio-Energy Systems	4
31.310	Drives & Power Quality	4
31.311	Modern Power System Operation & Control	4

31.312	Microcontroller & PLCs	4
31.313	Communication Engineering	4
31.401	Power System Control & Stability	4
31.402	Digital Signal Processing	4
31.403	Integrated Energy Systems	4
31.404	Nuclear Energy Systems	4
31.405	Energy Policy & Planning	4
31.406	Hydrogen Energy & Fuel cells	4
31.407	EHV AC-DC Systems	4
31.408	Energy Transportation & Storage	4
31.409	Energy from Waste	4
31.410	Advances in Thermal Power Engineering	4
31.411	Reactive Power Control & Facts	4
31.412	Geothermal & Ocean Energy	4
31.413	Entrepreneurship Development	4

31.101 Physics-1

Credits: 4

Content: Coherent sources, conditions for sustained interference. Division of Wave-Front - Fresnel's Biprism, Division of Amplitude- Wedge-shaped film, Newton's Rings, Michelson Interferometer, applications (Resolution of closely spaced spectral lines, determination of wavelengths). Difference between interference and diffraction Fraunhofer and Fresnel diffraction. Fraunhofer diffraction through a single slit, Plane transmission diffraction grating, absent spectra, dispersive power, resolving power and Rayleigh criterion of resolution. Polarised and unpolarised light, Uniaxial crystals double refraction, Nicol prism, quarter and half wave plates, Detection and Production of different types of polarized light, Polarimetry; Optical and specific rotation, Biquartz and Laurent's half shade polarimeter. Spontaneous and Stimulated emission, Laser action, characteristics of laser beam-concept of coherence, spatial and temporal coherence, He-Ne and semiconductor lasers (simple ideas), applications

31.102 Engineering Chemistry –I

Credits: 4

Content: Water-Hardness, determination of hardness by compleximetric (EDTA) method, degree of hardness, Chloride dissolved oxygen, dissolved carbondiozide and sulphate, calorimetric methods for the determination of pH, control of pH of water used in industry. Chemical Fuels – Classification of fuels, solid fuels, coal-origin and its classification, proximate and ultimate analysis of coal, significance of constituents, Gross and Net Calorific Values, Determiation of Calorific value by Bomb Calorimeter.Liquid Fuels – Advantages, Petroleum – origin, Classification, refining of petrol, Gasoline, Knocking – Octane Number, Chemical Structure and Knocking – Anti Knock agents.

31.103 Mathematics – I

Credits: 4

Content: Differential Calculus: Asymptotes- curves and curvature partial differentiation-Euler's theorem, total differential coefficient. Taylor's theorem for two variables, maxima and minima Lagrange's multiplier. Integral Calculus: Application of integral calculus area enclosed by curves length of arc. Volume and surface of evolution, Evolution of double and triple integrals, Gamma and Beta functions- Dirichlets's integral. Simple tests of convergence of integrals. Infinite Series: Convergence and divergence of series, tests of convergence, Alternating series, absolutely and conditionally convergent series, uniform convergence

31.104 Environment & Ecology

Credits: 4

Content: Definition, Scope & Importance, Need For Public Awareness- Environment definition, Eco system – Balanced ecosystem, Human activities – Food, Shelter, Economic and social Security, Natural Resources- Water Resources- Availability and Quality aspects. Water borne diseases, Water induced diseases, Fluoride problem in drinking water. Mineral Resources, Forest Wealth, Material cycles- Carbon, Nitrogen and Sulphur Cycles., Environmental Pollution and their effects. Water pollution, Land pollution. Noise pollution, Public Health aspects, Air Pollution, Solid waste management

31.105 Engineering Graphics

Credits: 4

Content: Basics of Engineering Drawing - Orthographic Projections – First angle projections of a point – Second, Third and Fourth angle projections – Projections of Lines situated in the first quadrant – Angles made by Lines with the Reference Planes – Projections of lines Parallel to One and Inclined to the other Reference Plane - Projections of lines inclined to both the Reference Planes – Traces. Solids – Projections of Solids having Axis Perpendicular to One of the Reference Planes - Projections of Solids having Axes Parallel to either to HP or VP and Inclined to Other. Cutting Planes – Drawing the Sections and Sectional Views with the axis of the solid vertical – True shape - Orthographic views of Pictorial Views – Sketching of Orthographic Views from Pictorial Views of Objects.

31.106 Physics-II

Credits: 4

Content: Space lattice, unit cell and translation vector, Miller indices, simple crystal structure. Laue's treatment to Bragg's law, powder method, Point defects in solids – Schottky and Frenkel defects. Bonding in solids- Ionic and covalent bonds. Discovery of Planck's constant, phase velocity and group velocity. Schrodinger wave equations-time dependent and time independent, Expectation value, Ehrenfest Theorem, particle in a one-dimensional box. Quantum Statistics, Features of nanosystems, Origin of energy bands, Kronig-Penny model (qualitative), E-K diagrams, Brillouin Zones, concept of effective mass and holes. Classification of solids into metals, Atomic magnetic moments, orbital diamagnetism. Classical theory of paramagnetism, ferromagnetism, molecular fields and domain hypothesis.

31.107 Engineering Chemistry –II

Credits: 4

Content: Terminology, One component system (H₂O system and CO₂ – system), two components system, Simple eutectic system (Pb – Ag), system with congruent melting point (Zn – Mg), system with incongruent melting point (Na₂SO₄ –H₂O), Cooling curves , Sources of water, impurities in water, hardness of water and its determination ,(EDTA method)units of hardness, alkalinity of water and its determination, Related numerical problems, scale and sludge formation (composition properties and methods of prevention) Boiler corrosion & caustic embrittlement, Additives for lubricants.

31.108 Mathematics II

Credits: 4

Content: Differentiation of vectors, scalar and vector point functions. Gradient of a scalar field and directional derivative, divergence and curl of a vector field and their physical interpretations. Integration of vectors, line integral, surface integral, volume integral, Green, Stoke's and Gauss theorems (without proof) and their applications. Exact differential equations, equations reducible to exact differential equations. Applications of differential equations of first order & first degree to simple electric circuits, Newton's law of cooling, heat flow and orthogonal trajectories, Formation of partial differential equations, Lagrange's linear partial differential equation, first order non-linear partial differential equation,

31.109 Basic Electrical & Electronics Engg

Credits: 4

Content: Semiconductor Physics, p-n junction in the breakdown region, Ideal diode, terminal characteristics of junction diode., Introduction of different types of amplifiers and their characteristics, Principle of amplification, Frequency response of RC coupled amplifiers, amplifier bandwidth and Concept of Cascaded Amplifiers, Feedback amplifiers, Effect of positive and negative feedback on amplifier gain and bandwidth, Oscillators, Binary, Octal and Hexadecimal number systems and conversions, Boolean Algebra, Truth tables of logic gates (AND, OR, NOT), NAND, NOR as universal gates, Difference between combinational circuits and sequential circuits, Introduction to flip-flops (S-R & J-K)

31.110 Basics of Civil & Mechanical Engg.

Credits: 4

Content: Surveying , classification, Civil Engineering Materials: Bricks – stones – sand – cement – concrete – steel sections., Classification of Power Plants – Working principle of steam, Gas, Diesel, Hydro-electric and Nuclear Power plants – Merits and Demerits – Pumps and turbines – working principle of Reciprocating pumps (single acting and double acting) – Centrifugal Pump.

31.111 Maths III

Credits: 4

Content: Review of the prerequisites such as limits of sequences and functions. Continuity, uniform continuity and differentiability. Rolle's theorem, mean value theorems and Taylor's theorem. Newton method for approximate solution Riemann integral and the fundamental theorem of integral calculus

31.112 Elements of Fluid Mechanics

Credits: 4

Content: Fluid Properties and Fluid Statics: Concept of fluid and flow, ideal and real fluids, continuum concept, and properties of fluids, Fluid Dynamics: Concept of system and control volume, Euler's equation, Bernoulli's equation, venturimeter, orifices, orificemeter, mouthpieces, kinetic and momentum correction factors, Impulse momentum relationship and its applications, Problems, Viscous Flow: Flow regimes and Reynolds's number, Relationship between shear stress and pressure gradient, uni-directional flow between stationary and moving parallel plates, movement of piston in a dashpot

31.201 Network Analysis & Synthesis

Credits: 4

Content: Circuit Concept –RLC parameters, voltage and current source, source transformation, voltage/current relationship for individual element, mutual inductance, Coupled Circuits - Inductively coupled circuits, coefficient of coupling, single and double tuned circuit resonance. Steady State Analysis - Step function response to RL, RC network and concept of time constant. Laplace transform method, basic theorems of Laplace transform. Waveform synthesis using step functions. Transform of pulse and periodic functions, concept of convolution integral. Transient Analysis- Initial conditions in networks, Poles & zeros of transfer function, one and two port networks, various two port network parameters, Interconnections of two port network. Network Theorems (AC). Frequency Domain Analysis - Sinusoidal steady state analysis, phasors and

phasor diagram, Fourier series, expansion of Fourier series, phase and amplitude spectrum, exponential form.

31.202 Electromechanical Energy Conversion

Credits: 4

Content: D.C. Generators - Emf equations, characteristics of D.C. generators. DC motors- Torque equation, characteristics, Starting, Braking & Speed control of D.C. motors, Losses & Efficiency of D.C. machine. Polyphase circuits : Line and phase quantities in star & delta-connected system, power in three phase systems. Three phase transformers, three phase bank of single phase transformers, parallel operations of 1 & 3 phase transformers. 3-phase Induction Machines -Constructional features, classification, Production of rotating magnetic field, working principle, phasor diagram, equivalent circuit, torque-slip characteristics, No-load and blocked rotor test, efficiency. Starting & speed control of Induction motor. Induction generator operation & characteristics. Synchronous Generators- Constructional features, classification

31.203 Analog & Digital Electronics

Credits: 4

Content: Transistor Biasing techniques, Small signal Amplifier ,Transistor as an amplifier ,Classification of amplifiers ,Load line DC equivalent circuit ,Operating point , RC coupled CE amplifier ,coupling and bypass capacitor ,ac equivalent circuit ,ac load line, current voltage and power gain ,input & output impedance analysis using h parameters ,frequency response & cascading. Power amplifiers, class A, class B , class A B, C amplifiers , their efficiency and power Dissipation. Push-pull and complimentary amplifier., Feedback amplifier , negative feedback, voltage-series, voltage shunt ,current series and current shunt feedback , Sinusoidal oscillators, L-C (Hartley-Colpitts) oscillators, RC phase shift, Wien bridge, and Crystal oscillators, 555 timer FET & MOSFET- The JFET, pinch off voltage, JFET V-I characteristics, FET small signal model, depletion mode MOSFET, enhancement mode MOSFET, low frequency common source and common drain amplifiers, FET biasing, FET as a voltage variable resistor. MOSFET as a switch, MOSFET driver circuits.

31.204 Thermodynamics

Credits: 4

Content: Basic concepts and properties:- Introduction, thermodynamic system and control volume, Macroscopic and microscopic approaches, properties and state of a system, point and path functions, Thermodynamic equilibrium, processes and cycles, Quasi-static process, properties such as specific volume, pressure, temperature etc. Equality of temperature, zeroth law of Thermodynamics, Temperature scales. Work and Heat: Definition of work, work done during various processes, p-v diagram, definition of Heat, Heat transfer a path function, comparison of heat and work, specific Heat and latent Heat. First law of thermodynamics: Energy of a system, classification of energy, law of conservation of energy law applied to closed system under going a cycle, Joules experiment. Energy a property of system, internal energy-a function of temperature, Enthalpy, specific heat at constant volume and constant pressure. Change in internal energy and Heat transfer during various non-flow processes. Ist Law applications to flow processes IInd Law of thermodynamics: Limitations of Ist law, heat engines and heat pumps

31.205 Maths IV

Credits: 4

Content: Matrices, Characteristics Polynomials, Probability and Statistics, random Variable, Density Function and distribution function, Curve Fitting, correlation coefficient, Karl persons and rank correlation techniques, regression analysis

31.206 Applied Mechanics & Materials

Credits: 4

Content: Stress concentration and its determination, Contact & Residual stresses, Rotating rims, discs, cylinders, With and Without Temperature variations, Bending of curved bars, Stresses and deflection calculations, Pressure Vessels, Unsymmetrical bending, Beam Columns, Bending of Beams of Variable cross sections. Torsion of non-circular section bars

31.207 Engineering Economics & Business Organization

Credits: 4

Content: Introduction to economics, its Importance, Principals, Approaches, and use of study, Engineering and economics, Economic problems, economic good and wealth, Demand and supply, Competition, Monopoly, theory of firm, Money and its function, theory of money and choice, the bank and its functions, employment and income, Gross National Product, Net National Product Consumption, Savings and investment Unit II: Features of Indian Economy-I Broad features of Indian Economy, Natural resources and economic development, Infrastructure in the Indian Economy, Agriculture development, Green revolution, Population, Population theories, Unemployment, Poverty, and Balance Regional Development. Economic Growth and Economic Development, Indian Industries, Industrial Policy, Industrialization in India, role, plan and pattern of Industrialization, Public vs Private Sectors, Economic reforms in India, India's Five Year Plans.

31.208 Energy Conversion System

Credits: 4

Content: Function and classification of prime movers, Properties of steam and their Determination, Thermodynamic vapour cycles: Carnot, Rankine and modified Rankine cycle. Continuity equation, Modern thermal power plants layout, various Components and accessories. Steam Turbines: Types of steam turbines, Flow through impulse and reaction turbine stages, Impulse and Reaction Turbines, Compounding, work done and stage velocity triangles, Blade and stage Efficiencies, Degree of reaction, Governing of Turbines, Methods of improvements in turbine efficiency, Losses in steam turbines, Back pressure turbines. Gas turbines: Types and principle of working. Hydraulic prime movers: Principles of hydraulic machinery, Layout of hydro power plants, Classification of modern water turbines – Impulse and Francis, Propeller, Kaplan and tubular (or Bulb) turbines, Main components and their Functions, Modern pelton turbine, Arrangements of jets, Design of components of Pelton turbine - Force, power and efficiency, Velocity triangles. Draft tube theory, Cavitation.

31.209 Conventional Energy Generation

Credits: 4

Content: Hydro-Electric Stations- Selection of site, Essential features and elements, Principal Auxiliaries, Plant Layout , Classification of Hydro power plants, Hydraulic Turbines, Water wheel Generators. Hydrology, Mass curve, flow duration curve, water storage, operating cost of

hydroelectric station. Thermal Power Stations: Selection of site for Coal fired power plants, Essential features and elements, Principal Auxiliaries, Plant layout, Steam Turbines, Turbo Alternators. Gas Electric power plants, Diesel Electric power plants. Operating costs. Nuclear Power Stations: Atomic energy fuels, Fission and fusion fundamentals, Basic construction and comparison of various types of nuclear reactors, Plant Layout, Risks and Safety measures. Comparison of various conventional energy systems, prospects and limitations. Economic Aspects of Power Plant Operation. Load curves, load factor, diversity factors and their significance, Costs of electrical energy, Interest and depreciation, Methods of determining depreciation Tariff, characteristics and types of tariff, Economic efficiency, Pay back period and Net-present value methods to assess financial efficiency of power plants.

31.210 Power Electronics

Credits: 4

Content: Basic concepts of construction, two Transistor Analogy, ratings of SCR, Static V-I characteristics, Dynamic Characteristics, gate characteristics, ratings, protection of SCR, turn on and turn off methods, series and parallel operation of SCRs, switching devices like diac, triac, power transistors, MOSFET, GTO, IGBT etc. Basic concepts of control circuit, synchronization circuit, isolation circuit. Various triggering circuits. Converter circuits: Single phase half wave, full wave, half controlled and fully controlled with resistive and inductive loads, use of feedback diode, three phase half wave & full wave converters, Dual Converters. Thyristor commutation methods, Principle of operation of chopper, types of choppers single, two and four quadrant choppers, voltage commutated chopper and current commutated choppers, Load Commutated Chopper.

31.211 Industrial Management

Credits: 4

Content: Fundamentals of Management – I: Management: Evolution, development, characteristics, principles, philosophy, Nature and function, (MBO), (MBE) their importance characteristics and applications. Fundamentals of Management – II: Organizational Behavior, Human behavior, Group dynamics. Leadership theories, styles and modern philosophies, motivation approaches and theories, communication, barriers and breakdowns, management information system, use of Computer in Management. Introduction to Personnel Management: Employees, Personnel Management practices, methods, recruitment, selection, interviews, group discussions, training, placement and employees development, wages and incentives, labour welfare, conflict, Negotiations, best practices. Introduction to Marketing and Sales Management: Marketing concept, principles, functions, market survey and research, concepts of sales and distribution, channels of distribution, salesmanship, sales promotions, methods of advertising, copy right, sales management practices.

31.212 Energy in Buildings

Credits: 4

Content: Types of energy like AC DC Natural, energy sources, energy requirements in Buildings. Method of energy conservation through passive cooling, heating and ventilation systems, Natural Lighting. Insulation Ventilation, Cooling, Solar Shading Design of low energy lighting systems in buildings, Energy Efficiency in Buildings, , LED, CFL, reflectors, energy efficient luminaries, electronic ballasts. Work examples of various Architects in this area through

history, TERI, Rated Buildings, Green Buildings, Model Sustainable habitat based on new and clean technologies Implication of above in design of energy conscious buildings. Geographical constraints in demand of Energy, Location, Site planning. Harnessing traditional architecture and modern science, use of renewable sources in buildings

31.213 New & Renewable Energy Resources

Credits: 4

Content: Solar Energy Solar Radiation: Extra terrestrial radiation, Spectral distribution, Solar constant, Solar radiations on earth, Measurement of solar radiations. Solar thermal Systems: Solar thermal power and its conversion, Solar collectors, Flat plate, Solar concentrating collectors, Types of concentrating collectors, applications. Photo voltaic (PV) technology: Photovoltaic effect, Efficiency of solar cells, Semiconductor materials for solar cells, Solar photovoltaic system, Standards of solar photovoltaic system, Applications of PV system. Wind and Small Hydro Power Energy Wind Energy: Wind data, Properties of wind, wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions. Availability of wind energy in India, Wind machine fundamentals, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Wind energy farms. Small, Mini and Micro Hydro Energy: Resource assessment of small, mini and micro hydro power; plants layout and their major components.

31.301 Microprocessors & Applications

Credits: 4

Content: Evolution and overview of Microprocessor, micro computer organization. Microprocessor Architecture - introduction and pin diagram of 8085, ALU timing and control unit, registers, data and address bus, timing and control signals, fetch and execute operations, instruction and data flow, system timing diagram, minimum system configuration for 8085. Instruction set, classification of instructions, addressing modes, instruction format, writing assembly language programs, concepts of stack, interrupts, interrupt service subroutine. Memory types, memory organization, static RAM interfacing memory, use of RAMs and EPROMs, RAM-6116, 6164, EPROM-2716, 2732, 2764, Programmable Peripherals Interface 8255. Programmable Interval Timer 8253.

31.302 Transmission & Distribution Systems

Credits: 4

Content: Power Supply Systems: Per unit system, Single-phase & three-phase system, Various types of transmission systems- Overhead and underground, choice of transmission voltage. Line parameters Line parameters, Inductance calculation, Inductance of 1-phase two wire transmission line and three phase line, Group conductors, Transposition of power line, Composite conductors, Bundled conductor, Skin & Proximity effect, Capacitance of single phase transmission line and 3- phase transmission line. Transmission lines: Representation of short, medium & long transmission line, ABCD constants, T & pie representation of transmission line, Cables, grading of cables, Types of Insulators, methods of equalizing the potential in string insulators, Surge impedance loading, Ferranti effect, Corona effect, Radio interference, Concept of sag & tension. Distribution Systems: Different type of ac & dc distribution system, Radial system, Ring main system, Various parts of distribution system, Feeder, Distributors, Service mains, Sub-station equipments.

31.303 Instrumentation & Control

Credits: 4

Content: Indicating Instruments - Basic elements of instrumentation, purpose of instrumentation, Sources of errors, their effects and analysis. Different methods of producing deflecting, controlling and damping torques. Torque equations, principle and operation of ammeters, voltmeters and wattmeters, moving iron and moving coil, dynamometer. Induction & electrostatic type of instruments. Extension of instrument range. Introduction and principle of operation of Anemometer, Lux-meter and different type of measuring instrument of solar insolation. PH-meter, instruments used in Temperature measurement in building energy. Detectors and Potentiometers. Transducers, LVDT Measurement of Energy- A.C. single phase and poly-phase induction type energy meters, errors in & methods of minimization, testing of energy meters by direct and phantom loading, maximum demand indicator, tri-vector meter, static energy meters.

31.304 Solar Energy Systems

Credits: 4

Content: Global distribution, Optimal system geometry, Insolation amount available on earth, Resource estimation, Solar data, Solar radiation spectrum, Seasonal and daily variation, Effect of tilt angle. Introduction, Flat plate collector, Type of Flat plate collectors, Efficiency of Flat plate collectors, Solar concentrating collectors, Classification of solar concentration, performance analysis of cylindrical- parabolic collectors, Materials for solar concentrators. Principles of applied heat transfer, glazing, evacuation, Selective surfaces, Solar thermal Applications, Water and Space Heating, Solar ponds, Dryers, Distillation, Solar Cooker. The photovoltaic effect, Spectral response, p-n junction, Different types of photovoltaic cells, PV cell characteristics, Effect of variation of temperature, Insulation level and tilt angle on the characteristics, Equivalent circuits.

31.305 Wind Energy Systems

Credits: 4

Content: Wind energy technology, Historical developments, latest developments, Indian scenario and worldwide developments, Nature of atmospheric winds; wind resource characteristics and assessment; anemometry; wind statistics; Types of wind turbines and their characteristics, Wind turbine dynamics, multiple stream tube theory, vortex, Pitch control, yaw control, Electrical and Mechanical aerodynamic braking, teeter mechanism. Types and characteristics of generators used in WECS,

31.306 Energy Conservation & Audit

Credits: 4

Content: General energy problem: Energy use patterns and scope for conservation, Energy conservation policy. Types of energy audits, Understanding energy costs, pay back period calculations maximizing system efficiencies, optimising the input energy requirements, Procedure, instruments, and techniques of Energy Audit. Mechanical Aspects : Thermodynamics of Energy Conservation, Basic principle, Irreversibility analysis of systems, Thermal energy audit in heating, ventilation air conditioning, First law efficiency second law efficiency, methods for preparing process flow, material energy balance diagram, identifying losses, improvements. Energy balance sheet and management information system, Electrical Aspects : Energy efficient

Lighting, Street Light Audit, Light Pollution and Light Maintenance. conservation in industry, Energy audit & management –Case studies of typical industries (textile, cement, pharma, paper, etc.) power plants & buildings. Co-Generation

31.307 Energy & Environmental Economics

Credits: 4

Content: Introduction to Energy Economics Basic economics and its use in energy analysis. Review of the basics of Supply, Demand and Price Formation in different markets. Overview of energy markets. Trends in energy production and consumption. Energy Demand: short Run and long run price and income elasticities. II. Economics of Energy Resources Primary (Extractive) Energy Industries: Coal, Oil and Natural Gas. Energy Conversion: Electric Utilities. Energy supply and the economics of depletable and renewable resources and Nuclear Energy. Energy flows in the economy - basic concepts, measurements and main issues. Pricing of Energy. Energy conservation and Demand Side Management. III. Introduction to Environmental Economics of Environment. Environmental Valuation. Property Rights, Market Failures and Externalities. Regulations and economic instruments for environmental protection (Pigovian approach, Coase theorem, Environmental Kuznets Curve, etc.). Environmental implications of energy use.

31.308 Energy Modeling

Credits: 4

Content: Energy Models. Surveys, Steady-State Computer Models, Dynamic Models: advantages and disadvantages, Interdependence of energy-economy-environment; Modeling concept, and application .Types of Energy Models-Issues related to renewable energy development-Energy Resource Assessment Models-Energy demand models-Capacity Determination/Sizing Models-Integrated Energy Supply System Models-Reference Energy systems-Electricity Planning Models. Energy modeling in the context of climate change Quantitative methods Basic concept of econometrics and statistical analysis; The 2-variable regression model; The multiple regression model; Tests of regression coefficients and regression equation; Econometric techniques used for energy analysis with case studies form India – Methodology for energy forecasting and decision making.

31.309 Bio –Energy System

Credits: 4

Content: Bio energy as by product of waste processing, Biomass classification, Environmental significance, Introduction to anaerobic digestion, Energy plantation, Process fundamentals and design considerations, physical method of bioconversion i.e. Briquetting, pelletization, Energy assessment, Types of reactors, Energy farming. Biogas – A rural energy source, Biogas technology, Types of Biogas plants-components , Selection of model of biogas plant, factors affecting biogas yield, Biogas from landfills , Rural & Urban energy loads, Animal waste, Forest & Agro residue,. Biomethanation from sludge digestion, Methane production, capacity designing & thermal power availability calculations. Thermo-chemical characteristics of biomass, proximate analysis, Ultimate analysis, Ash deformation, Liquefaction of biomass, Biomass processing, Pyrolysis, chemical reaction in Gasification & Combustion of biomass, Types of Gasifiers, Producer gas and its constituents, Application of producer gas.

31.310 Drives & Power Quality

Credits: 4

Content: Introduction of Electrical Drives, Fundamental speed torque conventions and Multi-quadrant operation, nature of load torques, Selection of Drive. D.C. Motor Drives & their classification, their performance curve, and their industrial applications. Parameters of speed control, speed reversal, starting & elect. braking. Solid state control of D.C. Drives, Advantages, Converter fed D.C. Drives, Chopper fed D.C. Drives comparison & applications . Induction Motor Drives Eq. ckt. analysis Torque production, parameters of speed control, speed reversal/starting elect. Braking, stator & rotor side control, Variable voltage, variable frequency operation, VSI Fed/ CSI Fed AC Drives, Kramer's control of drive. Synchronous motor, Brushless DC motor and their industrial applications, operation from fixed frequency supply, synchronous motor variable speed drives, Calculation of energy loss & energy efficiency, Energy conservation in Electrical Drives.

31.311 Modern Power System Operation & Control

Credits: 4

Content: Power System Structure PS operating states, control problem, control loops, hydraulic and steam turbines, effect of exciter and governor excitation system: its requirements, functions, types and modeling of ES Control Power, Frequency characteristics, control of voltage, frequency and tie line power flows, automatic generation control, under frequency load shedding. Relation between voltage, power and reactive power, generation and absorption of reactive power, voltage control and voltage stability analysis PS Planning National and regional planning, PS reliability, load management, load prediction, reactive power balance, computerized management and PC simulator.

31.312 Microcontroller & PLCs

Credits: 4

Content: Introduction to Microcontroller, History of microcontrollers, Applications of microcontrollers, Features of microcontrollers Popular chips. Fabrication techniques, Program development tools, Advanced memory options. Introduction to microcontroller 8051, architecture, Hardware details, Timing diagrams, Memory Organisation and applications, microcontroller 8051 instruction set, assembly language programming, stack operation, Interrupt system conditional jumps, special control instructions, shift instructions.

31.313 Communication Engineering

Credits: 4

Content: Need for Modulation, Amplitude Modulation, AM Demodulator, SSB Modulation, Vestigial Sideband Modulation, AM transmitter and Receiver, Noise and bandwidth in AM, Carrier Communication, Basic Principles of Pulsed and CW Radar. Frequency Modulation, FM Demodulator, Phase Modulation, FM transmitter and receiver, Noise and bandwidth in FM, Ground wave, sky wave and space wave propagation, Basic Principles of BW and Colour TV. Sampling theorem, PAM, PWM, PPM, Pulse Code Modulation, Noise in PCM, Delta Modulation, Adaptive Delta modulation, DPCM, M'ary system, FDM and TDM.

31.401 Power System Control & Stability

Credits: 4

Content: Excitation system requirement, Elements of an excitation system, types of excitation systems, comparison of the various excitation system, Development of Block diagram of excitation system and the transfer function. Recent development and future trends. Nature of control problems, Basic concept of Governor Mechanism and their performance in steady state, Turbine and Generator model. Load frequency control of an isolated power system. Division of load between Generators, Basic concept of control area. Generation and absorption of reaction power, relation between voltage, power and reactive power at a node, methods of voltage control. Injection of reactive power, use of tap changing transformers, combined use of tap changing transformers and reactive power injection.

31.402 Digital Signal Processing

Credits: 4

Content: Classification of signals, Multichannel and multi dimensional continuous v/s discrete time signals, continuous v/s discrete valued signals, continuous time sinusoidal signal, discrete time sinusoidal signals, sampling of analog signal, sampling theorem, quantification and coding of D/A conversion. Discrete time signal, systems, Z-transform & Inverse Z-transform, analysis of discrete time, linear time invariant systems, co-relation of discrete time systems. Frequency analysis of analog signals, frequency analysis of discrete time signals. Properties of Fourier Transform, Frequency Domain Characteristics, Time Frequency Dualities, Sampling of signals in time and frequency domain, Design of linear phase FIR filter using window & frequency sampling method. Design of equiripple linear phase filters. Comparison of design methods for linear phase FIR filters. Design of IIR filters from analog filters. Direct Design Technique for digital IIR filters.

31.403 Integrated Energy Systems

Credits: 4

Content:: Energy Storage Technologies:, Necessity of energy storage, Energy storage methods, Mechanical Energy storage, Thermal energy storage Chemical Energy storage, Electro magnetic storage, Electrostatic energy storage and biological energy storage. Stand Alone and Hybrid Energy Systems Economics Evaluation-Mathematical Modeling of Integrated Energy Systems, Energy Modeling for optimization of different systems, Case studies. Integrated Energy Systems Harnessing, Storing and Converting energy sources-Barriers encountered, Integrated Systems for cooling, heating & power. CHP and Co-generation Need for cogeneration, Principle, Classification Technical options, Prime movers for Cogeneration, Economics of Cogeneration, and Performance assessment of Co-generation plant

31.404 Nuclear Energy Systems

Credits: 4

Content: Introduction, Atomic Nuclei, Atomic Number and Mass Number, Isotopes, Atomic Mass Unit, Radioactivity and Radioactive Decay, Mass – Energy Equivalence, Binding Energy, Release of Gas cooled reactors – Radioactivity of gas coolants – Analysis of gas cycle – Steam cycle – Simple and dual pressure cycle – Pebble bed reactors. Liquid metal cooled reactors – Compatibility with materials – Fast reactors – Fluid fuel reactors – types – Corrosion and Erosion characteristics Introduction, Fuels, Cladding and Structural Materials Coolants, control Rod Materials, Shielding Materials. Types of Nuclear Waste, High, intermediate and low level wastes- Effects of Nuclear Radiation, Radioactive Waste Disposal System, Gas Disposal System.

Safety Rules: Personal Monitoring, Radiation Protection Radiation Workers, Non-Radiation Workers, Public at large

31.405 Energy Policy & Planning

Credits: 4

Content: Location of Energy Manager, Top Management Support, Managerial functions, Role and responsibilities of Energy Manager, Accountability. Motivating – Motivation of employees, Requirements for Energy Action Planning. Information Systems: Designing, Barriers, Strategies, Marketing and Communicating Training and Planning.

31.406 Hydrogen Energy & Fuel cells

Credits: 4

Content: Hydrogen Energy & Applications Hydrogen: Its merit as a fuel; Applications. Hydrogen Economy: Hydrogen and fuel cell; Suitability of Hydrogen as a fuel and fuel cell as energy conversion device Hydrogen Storage and Transport Storage: Metal hydrides, Metallic alloy hydrides, Carbon nano-tubes;. Fuel Cell: Basics Fuel cell definition, difference between batteries and fuel cells, fuel cell history, components of fuel cells, Advantages and disadvantages of fuel cell power plant. Types of Fuel Cells Fuel cell types: alkaline fuel cell, , polymer electrolyte fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, High temperature, intermediate temperature ,Single chamber solid oxide fuel cells, Problems with fuel cells, applications of fuel cells.

31.407 EHV AC-DC Systems

Credits: 4

Content: Constitution of EHV A.C. and D.C. links, kind of D.C. links, limitation and Advantages of A.C. and D.C. transmission, principal application of A.C. and D.C. transmission, trends in EHV A.C. and D.C. transmission power handling capacity. Traveling waves on transmission systems, their shape, attenuation and distortion, effect of junction and termination on propagation of traveling waves. Over-voltages in transmission system: lightning, Converter theory and performance equations – Value characteristics, converter circuits, abnormal operation of converter circuits, harmonics and filters, Control of HVDC systems – Basic principles of control, control implementation, converter firing control system, valve blocking and bypassing, starting, stopping and power flow reversal.

31.408 Energy Transportation & Storage

Credits: 4

Content: Energy transportation: bulk transportation of fuels- characteristics of transportation systems for solid liquid and gaseous fuels; Energy Storage: Overview of storage technologies, Principle forms of stored energy, various energy storage devices, Applications of Energy storage, Specifying Energy Storage Devices, Specifying Fuels, Direct electric storage: Ultracapacitors, Electrochemical Energy Storage: Secondary Batteries, Lead-Acid, Lithium-Ion, Nickel-Cadmium, Nickel-Metal Hydride, Sodium-Sulfur, Zebra, Flow Batteries and Flywheels. Direct Thermal Storage: Sensible heat, Latent heat. Thermochemical Energy Storage: Biomass solids, Ethanol, Biodiesel and Syngas

31.409 Energy from Waste

Credits: 4

Content: Waste Heat Recovery: Classification, advantages and applications, commercially viable waste heat recovery devices, is saving potential. techno economics environmental considerations Introduction - Principles of Thermodynamics and Second Law - sources of Waste Pollution, Definitions - Sources, Types, Compositions, Properties of Solid Waste - Municipal Solid Waste - Physical, Chemical and Biological Property - Collection - Transfer Stations – Waste hazardous waste management ,Size Reduction - Aerobic Composting - Incineration - Furnace Type & Design Pharmaceutical Waste Incineration - Environmental Impacts - Measures of Mitigate Biochemical Conversion - Sources of Energy Generation - Industrial Waste, Agro Residues - Anaerobic Digestion - Biogas Production - Types of Biogas Plant Thermo chemical Conversion - Mechanical biological treatment (MBT), Biodrying, UASB, Recycling, Determination of the biomass fraction the manual sorting method and the selective dissolution method

31.410 Advances in Thermal Power Engineering

Credits: 4

Content: Combustion equipment for burning coal, Preparation and handling of coal - Pulveriser – Dust collector - Ash removal; Stokers - Different types -mechanical stokers, pulverized coal firing system- Fluidized bed combustion -its advantages & disadvantages, Draught - Different types - Chimney design, Cooling towers-burners & furnaces. Principle of circulation-natural forced circulation, drafts-natural, forced, induced & alanced drafts, Comparison and selection Modern high pressure and supercritical boilers - Analysis of power, plant cycles - modern trends in cycle improvement- --combined brayton and Rankine cycle, power plants, Combustion efficiency, Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical, analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced, convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes;, heat exchanger performance, gas turbine Analysis –Open and Closed Cycles, Inter cooling-Regeneration - Reheating, Isentropic efficiency-Application

31.411 Reactive Power Control & Facts

Credits: 4

Content: Introduction to FACTS- Basic Types of FACTS controllers, Description and definition of FACTS controllers – Benefits from FACTS technology- Static Var Compensator(SVC): Principle of operation, configuration and control, Thyristor Controlled Series compensator(TCSC): Unified Power Flow Controller(UPFC): Simulation of UPFC, Steady state model of UPFC, Interline Power Flow Controller(IPFC), ,Analysis and Design of FACTS based stabilizers: Analysis of damping torque contribution by FACTS based stabilisers installed in SMIB systems, Design of robust FACTS based stabilizers installed in SMIB systems by phase compensation method - Selection of installing locations and feed back signal for FACTS based stabilizers Transient Stability control with FACTS: Analysis of Power systems installed with FACTS devices: Power transmission control using Controllable Series Compensation(CSC), SSSC, UPFC.

31.412 Geothermal & Ocean Energy

Credits: 4

Content: Introduction of Geothermal Energy, Origin and Renew ability of geothermal energy, History of geothermal resources, Utilization of geothermal resources, Direct utilization; Swimming bathing & balneology, space conditioning, district heating, Agribusiness application, industrial application, Electricity generation; Geothermal heat pump; basic concept of heat pump, air conditioner, heating and cooling mode in heat pump

31.413 Entrepreneurship Development

Credits: 4

Content: Entrepreneurship Development and Management is one of the core competencies of technical human resource. Creating awareness regarding entrepreneurial traits, entrepreneurial support system, opportunity identification, project report preparation and understanding of legal and managerial aspects can be helpful in motivating technical/ vocational stream students to start their own small scale business/enterprise.