33
448

SYLLABUS -PHYSICS

Mechanics: Vectors, vector triple product, gradient, divergence and curl, Gauss's, Stoke's theorems. Rotational motion, torque, angular momentum, moment of inertia, moment of inertia, theorems of perpendicular and parallel axes, moment of inertia of regular shaped bodies. Gravitation, Kepler's laws of planetary motion. Elastiity, surface tension, excess pressure inside soap bubble, capillarity, viscosity, Bernoulli's theorem and its applications.

Simple harmonic motion, free and damped oscillations, wave equation, beats, resonance, Doppler's effect.

Heat and Thermodynamics: Zeroth law of thermodynamics, temperature scales, first law of thermodynamics, reversible, irreversible processes, isothermal, adiabatic processes, second law of thermodynamics, Carnot cycle.

Electricity and magnetism: Coulomb's law, electric field and potential, Gauss's law and its applications, capacitor, parallel and series combination, energy stored in electric field.

Current electricity, thermoelectric effect, Seebeck, Peltier and Thomson effects, Growth and decay of current in L-R, C-R and LCR circuits.

Alternating current, peak, average and rms values of current, AC through R, C and L circuits, AC through RC, RL and LCR circuits, phasor diagrams, LC oscillations, power in AC circuits.

Magnetic field due to circular loop, Biot-Savart law, Ampere's law, solenoid, magnetic susceptibility, permeability, magnetization, dia-, para- and ferromagnetism. Hyteresis, electromagnetic induction, Faraday's and Lenz's law, self and mutual induction. AC and DC generators, transformers.

Optics: Mirrors and Lenses, Magnifying power, simple and compound microscope, telescope, coherent and incoherent sources, Young's double slit experiment, diffraction by single slit, grating, polarization.

Modern Physics: Spectra of hydrogen atom, Bohr's atom, x-rays, continuous and characteristics x-rays, Mosley's law, matter waves, experimental verification of de Broglie waves, uncertainty principle, constituents of nuclei, nuclear size, mass defect, binding energy, radioactivity, radioactive decay, mean and half life.

Electronics: Semiconductor, p-n junction diode and its I-V characteristics, rectifier, zener diode and its applications, transistor, transistors as amplifiers.

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(341)
448A

Mechanical Engineering

Engineering Mechanics & Strength Of Materials: Vector concepts, rest and motion, Introduction to force systems (Parallel, Concurrent & Coplanar); Free Body Diagram; Equilibrium principle; Static analysis of systems; Friction and impending motion; rolling and sliding of cylinders; Newton's law of motion and derived concepts. Centroid; Area & mass moment of inertia. Work-Energy principle; Impulse; Collision of two bodies; Plane motion of particles and applications; Static analysis of simple structures; Method of joints and method of sections. Virtual work; combined motion of rotation and translation; Transmission of power by belt and gear drives.

Stress & strain, Shear stresses, Principal stress and strain, Mohr's circle for stress and strain analysis, Beams & columns; Shear force and bending moment diagram. Theories of Failures; Columns, Struts; Stress & strain analysis of shafts under torsion, analysis of springs, Bending Stress, Deflection.

Engineering Materials: Mechanical, thermal, chemical properties, structure of materials, alloys. Iron and its alloys, Iron carbon phase diagrams, steel and their important alloys of iron, heat treatment processes, Elastic & plastic behaviors; Plastic deformation. Effect of various alloying elements on mechanical properties of Iron: Bearing alloys; Powder metallurgy;. Commonly used engineering materials for tools, engineering components and household objects.

Design of Machine Element: Concept of FOS, limits, fits, tolerance, material selection, engineering materials, Design of Rivets, Screws, Bolts with detail analysis. Cotter and Knuckle joints, shafts, keys and couplings, Springs – helical and leaf types.

Hydraulics and Hydraulic Machines: Properties of liquid, hydraulic pressure and its measurement, Forces on immersed bodies; Center of pressure; Buoyancy stability of immersed and floating bodies; Flow of liquids: 1-D, 2-D, & 3-D flows; steady, unsteady, laminar and turbulent flows; continuity equation, momentum equation, and energy equation and their applications, Euler equation and Bernoulli's equation; Orifice, mouth piece and nozzles, flow through pipes and piping systems, losses in piping systems; fundamentals of channel flow, hydraulic jump; flow measurements : Dimensional analysis and associated theorems. Non dimensional numbers and their significances; Stream function and velocity potential function; streamline, streakline and pathline; Rotational and irrotational flow, circulation and vorticity; Free and forced vortex; Basic flows like rectilinear, source, sink, doublet etc. Different types of pump, reciprocating and rotary pumps, operation and maintenances of pumps, Cavitation and NPSH; Characteristic curves of pumps, losses and efficiencies of pumps. Compressors, blowers and fans. Different types of turbines, Francis, Kaplan and Pelton turbines, operation and maintenance of turbines; characteristic curves, work done and efficiency of turbine, specific speed and selection of pumps and turbines. Hydraulic machinery like hydraulic ram, hydraulic coupling and torque converter, hydraulic jack, screw pump, Gear pump, Vane pump etc.

Thermal Engineering: Basic thermodynamic concepts; System and surrounding; Thermodynamic Properties; Intensive and Extensive properties; Point and path functions; Zeroth law, first and second laws of thermodynamics and associated corollaries; Concepts of absolute temperature, internal energy, enthalpy &entropy; Clausius inequality, concept of availability,

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Maxwell's relations. Application of thermodynamic laws, reversibility & irreversibility , internal & external irreversibility; Pure substances and mixtures. Thermodynamic cycles; Carnot cycle, Rankine cycle, Joule-Brayton cycle ; Air standard cycles; Otto cycle and Diesel cycles. Ideal gas compression and compressors, jet propulsion, gas compressors, stream generators, Fuel and combustion, I.C. engine, calculation of efficiencies, testing of IC. Engines; Open and closed gas turbine cycles, introduction to heat and mass transfer; heat exchanger; LMTD and NTU methods. Principles of refrigeration, air refrigeration system, Vapor compression refrigeration system, refrigeration cycles, use of T-S & P-H charts for refrigeration, refrigerants and their properties, vapor absorption system, psychometric properties and charts, Cooling load and air conditioning calculations, Types of power plants; components of steam power plant; hydro-electric power plant, nuclear power plants, diesel power plant, Elementary solar and geothermal power systems.

Theory of Machines: Kinematics and kinetics; mechanisms and structure; inversions; kinematic chains; different types of mechanisms; degree of freedom & its determination; Grashof's criteria; velocity analysis; acceleration analysis; gear trains; balancing of rotating masses; brakes & dynamometer.

Production and Industrial Engineering: Fundamentals of metal cutting, tool geometry, Calculations of cutting forces and tool life; General purpose machine tool and their operations, various welding techniques like arc, gas, resistance etc. Metal forming methods like rolling, drawing, extrusion, press working, powder metallurgy, heat treatment of metals, Introduction to NC and CNC machines, basics of measuring instruments, study of transducers, static and dynamic characteristic of instruments, Introduction to metrology: Limits, fits and tolerance, Mechanical and optical comparators; Measuring instruments of angles; measurements of surface roughness and thread profiles, calibration of various measuring instruments. Production planning; Inventory control; material and wage calculation; elements of cost; network analysis; work study and estimating machining time; break even analysis; TQM & ISO 9000; Shop floor management; Machines & Industrial safety.

Mechanical Measurements: Measurement of displacement, velocity, acceleration, force, torque, strain, speed, temperature, pressure, flow, shock, vibration and sound.

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4/4/8(15)

ELECTRICAL ENGINEERING SYLLABUS

1. EM Theory

Electric and magnetic fields. Gauss's Law and Amperes Law. Fields in dielectrics, conductors and magnetic materials. Maxwell s equations. Time varying fields. Plane-Wave propagating in dielectric and conducting media. Transmission lines.

2. ELECTRICAL MATERIALS

Band Theory, Conductors, Semi-conductors and Insulators. Super-conductivity. Insulators for electrical and electronic applications. Magnetic materials. Ferro and ferri magnetism. Ceramics, Properties and applications. Hall effect and its applications. Special semi conductors.

3. ELECTRICAL CIRCUITS

Circuits elements. Kirchoff s Laws. Mesh and nodal analysis. Network Theorems and applications. Natural response and forced response. Transient response and steady state response for arbitrary inputs. Properties of networks in terms of poles and zeros. Transfer function. Resonant circuits. Threephase circuits. Two-port networks. Elements of two-element network synthesis.

4. MEASUREMENTS AND INSTRUMENTATION

Units and Standards. Error analysis, measurement of current, Voltage, power, Power-factor and energy. Indicating instruments. Measurement of resistance, inductance, Capacitance and frequency. Bridge measurements. Electronic measuring instruments. Digital Voltmeter and frequency counter. Transducers and their applications to the measurement of non-electrical quantities like temperature, pressure, flow-rate displacement, acceleration, noise level etc. Data acquisition systems. A/D and D/A converters.

5. CONTROL SYSTEMS

Mathematical modeling of physical systems. Block diagrams and signal flow graphs and their reduction. Time domain and frequency domain analysis of linear dynamical system. Errors for different type of inputs and stability criteria for feedback systems. Stability analysis using Routh-Hurwitz array, Nyquist plot and Bode plot. Root locus and Nicols chart and the estimation of gain and phase margin. Basic concepts of compensator design. State variable matrix and its use in system modelling and design. Sampled data system and performance of such a system with the samples in the error channel. Stability of Sampled data system. Elements of non-linear control analysis. Control system components, electromechanical, hydraulic, pneumatic components.

6. ELECTRCIAL MACHINES AND POWER TRANSFORMERS

Magnetic Circuits – Analysis and Design of Power transformers. Construction and testing. Equivalent circuits. Losses and efficiency. Regulation. Auto-transformer, 3-phase transformer. Parallel operation.

Basic concepts in rotating machines. EMF, torque, Basic machine types. Construction and operation, leakage losses and efficiency.

B.C. Machines. Construction, Excitation methods. Circuit models. Armature reaction and commutation. Characteristics and performance analysis. Generators and motors. Starting and speed control. Testing, Losses and efficiency.

Synchronous Machines. Construction. Circuit model. Operating characteristics and performance analysis. Synchronous reactance. Efficiency. Voltage regulation. Salient-pole machine, Parallel operation. Hunting. Short circuit transients.

Induction Machines. Construction. Principle of operation. Rotating fields. Characteristics and performance analysis. Determination of circuit model. Circle diagram. Starting and speed control.

Fractional KW motors. Single-phase synchronous and induction motors.

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7. POWER SYSTEMS

Types of Power Stations, Hydro, Thermal and Nuclear Stations. Pumped storage plants. Economics and operating factors. Power transmission lines. Modeling and performance characteristics. Voltage control. Load flow studies. Optimal power system operation. Load frequency control. Symmetrical short circuit analysis. ZBus formulation. Symmetrical Components. Per Unit representation. Fault analysis. Transient and steady-state stability of power systems. Equal area criterion. Power system Transients. Power system Protection Circuit breakers. Relays. HVDC transmission.

8. ANALOG AND DIGITAL ELECTRONICS AND CIRCUITS

Semiconductor device physics, PN junctions and transistors, circuit models and parameters, FET, Zener, tunnel, Schottky, photo diodes and their applications, rectifier circuits, voltage regulators and multipliers, switching behavior of diodes and transistors.

Small signal amplifiers, biasing circuits, frequency response and improvement, multistage amplifiers and feed-back amplifiers, D.C. amplifiers, Oscillators. Large signal amplifiers, coupling methods, push pull amplifiers, operational amplifiers, wave shaping circuits. Multivibrators and flip-flops and their applications. Digital logic gate families, universal gates-combination circuits for arithmetic and logic operational, sequential logic circuits. Counters, registers, RAM and ROMs.

9. MICROPROCESSORS

Microprocessor architecture-Instruction set and simple assembly language programming. Interfacing for memory and I/O. Applications of Micro-processors in power system.

10. COMMUNICATION SYSTEMS

Types of modulation; AM, FM and PM. Demodulators. Noise and bandwidth considerations. Digital communication systems. Pulse code modulation and demodulation. Elements of sound and vision broadcasting. Carrier communication. Frequency division and time division multiplexing, Telemetry system in power engineering.

11. POWER ELECTRONICS

Power Semiconductor devices. Thyristor. Power transistor, GTOs and MOSFETS. Characteristics and operation. AC to DC Converters; 1-phase and 3-phase DC to DC Converters; AC regulators. Thyristor controlled reactors; switched capacitor networks.

Inverters; single-phase and 3-phase. Pulse width modulation. Sinusoidal modulation with uniform sampling. Switched mode power supplies.

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(78) (4CBE)

CIVIL ENGINEERING

SOIL MECHANICS AND GEOTECHNICAL ENGINEERING.

Origin of soils, soil classification, three-phase system, fundamental definitions, relationship and interrelationships, permeability & seepage, effective stress principle, shear strength, consolidation, compaction,

Sub-surface investigations- scope, drilling bore holes, sampling, penetration tests, plate load test. Earth pressure theories, effect of water table, layered soils. Stability of slopes-infinite slopes, finite slopes. Foundation types-foundation design requirements. Shallow foundations-bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands & clays. Deep foundations pile types, dynamic & static formulae, load capacity of piles in sands & clays, negative skin friction.

FLUID MECHANICS AND WATER RESOURCES ENGINEERING

Properties of fluids, principle of conservation of mass, momentum, energy and corresponding equations, potential flow, applications of momentum and Bernoulli's equation, laminar and turbulent flow, flow in pipes, Concept of boundary layer and its growth. Uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies, flow measurements in channels, tanks and pipes. Dimensional analysis and hydraulic modeling. Kinematics of flow specific speed of pumps and turbines.

Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, unit hydrographs, flood estimation, reservoir capacity, reservoir and channel routing. Well hydraulics.

Duty, delta, estimation of evapo-transpiration. Crop water requirements. Design of: lined and unlined canals, waterways, head works, gravity dams. Design of weirs on permeable foundation. Types of irrigation.

Rainfall, stream flow measurements, runoff, hydrographs. Flood studies, reservoir and channel routing , flood forecasting. Flood protection measures ,river training works, well hydraulics. Irrigation: Command area and crop-water requirement.

STRENGTH OF MATERILAS & THEORY OF STRUCTURES:

Normal stress, shearing stress .Normal strain. Hooke's Law. Stress strain behaviour of mild steel, Poisson's Ration. Shearing strain. Torsion of Circular shaft. Relations among load. Shear and Bending Moment. Shear and Bending Moment Diagrams. Pure Bending . Bending

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of members. Made of several Materials. Shearing stresses in a Beam. Mohr's circle for plain stress. Principal stresses. Maximum Shearing stress. Euller's formula for pin- Ended columns and columns with other End conditions. Equation of the Elastic Curve by Double Integration method, slope and Deflection of Determinate Beams by Momenet Area Theorems. Deflections and slope by Energy Methods. Castigliano's Theorem. Stability and Degree of indeterminacy. Rolling loads and influence lines for Determinate Beams. Trusses and floor Ginders. Cables and Three-Hinged Arch.

STRUCTURAL DESIGN.

Concrete Technology- properties of concrete, basics of mix design., Working stress methods of design, singly and doubly reinforced sections, rectangular and Test beans, shear torsion and development length one and two way slabs, short and long column, Design of isolated footings, Introduction of limit state design. Design for flexure, shear and compression. Design of riveted and welded connections, tension and compression members,
Splicing and lacing. Beam column connection. Roof trusses.

HIGHWAY AND RAILWAY ENGINEERING.

Highway geometric Design. Cross sectional elements. Sight distances horizontal and vertical alignment, Types and components of Pavement structures. Design of flexible Pavements. Traffic characteristics : Road user and vehicular characteristics, traffic volume studies, O-D studies and traffic capacity studies.

Railways: Components, construction and maintenance of rail tracks. Points and crossing.

SURVEYING:

Contouring . Theodolite and its adjustment. Measurement of angles and setting out lines. Trigonometrical leveling . Tacheometry. Curves and different methods of setting out curves, introduction to electronic. Theodolites and total stations.

ENVIRONMENTAL ENGINEERING;

Estimation of quantity of water per capital demand, population forecasting, water quality parameters, treatment of water, distribution system. Estimation of quantity of sewage, dry weather flow and storm run off. Sewer appurtenances, characteristics off sewage, treatment and disposal of sewage sludge digestion .

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Electronics and Communication Engineering

Materials and Components :

Structure and properties of Electrical Engineering materials; Conductors, Semiconductors and Insulators, magnetic, Ferroelectric, Piezoelectric, Ceramic, Optical and Super-conducting materials. Passive components and characteristics Resistors, Capacitors and Inductors; Ferrites, Quartz crystal Ceramic resonators, Electromagnetic and Electromechanical components.

Physical Electronics, Electron Devices and ICs:

Electrons and holes in semiconductors, Carrier Statistics, Mechanism of current flow in a semiconductor, Hall effect; Junction theory; Different types of diodes and their characteristics; Bipolar Junction transistor; Field effect transistors; Power switching devices like SCRs, GTOs, power MOSFETS; Basics of ICs - bipolar, MOS and CMOS types; basic of Opto Electronics.

Networks:

Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis ofsimple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices:

Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, and resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, Basics of LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits:

Small Signal Equivalent circuits of diodes, BJTs, MOSFETs and analog CMOS. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential and operational, feedback, and power. Frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single transistor and op-amp configurations. Function generators and wave-shaping circuits, 555 Timers. Power supplies.

Digital Electronics:

Boolean algebra, minimization of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinatorial circuits: arithmetic circuits, code converters, multiplexers, decoders, PROMs and PLAs. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

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Signals and Systems:

Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, DFT and FFT, z-transform. Sampling theorem. Linear Time-Invariant (LTI) Systems: definitions and properties; causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay. Signal transmission through LTI systems.

Control Systems:

Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.

Communications:

Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density. Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Fundamentals of information theory and channel capacity theorem. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwidth consideration and probability of error calculations for these schemes. Basics of TDMA, FDMA and CDMA and GSM.

Electromagnetics:

Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; S parameters, pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Basics of propagation in dielectric waveguide and optical fibers. Basics of Antennas: Dipole antennas; radiation pattern; antenna gain.

Electronic Measurements and instrumentation:

Basic concepts, standards and error analysis; Measurements of basic electrical quantities and parameters; Electronic measuring instruments and their principles of working : analog and digital, comparison, characteristics, application. Transducers; Electronic measurements of non electrical quantities like temperature, pressure, humidity etc; basics of telemetry for industrial use.

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