

Syllabus & Eligibility for Entrance Exam 2016 of Physics and Electronics

Eligibility:

M.Sc. Physics & Astrophysics: B.Sc. with Physics, Mathematics and Chemistry/Information Technology/Computer Science

M.Sc. Electronics: B.Sc. with Physics, Mathematics and Electronics/Chemistry/Information Technology/Computer Science/EEM

Syllabus:

MECHANICS, OSCILLATIONS AND PROPERTIES OF MATTER

Laws of motion, centripetal acceleration, Coriolis force and its applications, Kepler's laws, Gravitational law and field, System of particles, center of mass, equation of motion, conservation of linear & angular momentum, conservation of energy

Rigid body notion, rotational motion, moments of inertia and their products, principle moments & axes, periodic oscillations, kinetic and potential energy, examples of simple harmonic oscillations, spring and mass system, simple and compound pendulum, torsional pendulum.

Resonator, LC circuit, vibrations of a magnet, oscillations of two masses connected by a spring, Superposition of two simple harmonic motions of the same frequency, power absorption, resonance.

E as an accelerating field, electron gun, case of discharge tube, linear accelerator, E as deflecting field-CRO sensitivity, Transverse B field, 180° deflection, mass spectrograph, principle of a cyclotron, mass spectrography.

Elasticity, Hooke's law, Kinematics of moving fluids, equations of continuity, Euler's equation, Bernoulli's theorem, viscous fluids, stream-line and turbulent flow, Poiseuille's law, Capillary tube flow, Reynold's number, Stokes law, surface tension and surface energy, molecular interpretation of surface tension, pressure on a curved liquids surface, wetting.

ELECTRICITY, MAGNETISM AND ELECTROMAGNETIC THEORY

Scalars and vectors, dot and cross products, triple vector product, gradient of a scalar field and its geometrical interpretation, divergence and curl of a vector field, line, surface and volume integrals, flux of a vector field, Gauss's divergence theorem, Green's theorem and Stokes theorem.

Coulomb's law, Work done on a charge in an electrostatic field, conservative nature of the electrostatic field. Electric potential, torque on a dipole in a uniform electric field and its applications, Fields at the surface of a conductor, capacitors, electrostatic field energy, force per unit area of the surface of a conductor in an electric field, conducting sphere in a uniform electric field.

Parallel plate capacitor, electric susceptibility, permittivity and dielectric constant, polarization and polarization vector, displacement vector, Clausius-Mossotti equation, current density, Kirchhoff's law, rise and decay of current in LR and CR circuits, decay constants, transients in LCR circuits, AC circuits, complex numbers and their applications in solving AC circuit problems, complex impedance and reactance, series and parallel resonance, Q factor, power consumed by an AC circuit, power factor.

Lorentz force equation and definition of B, force on a straight conductor carrying current in a uniform magnetic field, torque on a current loop, magnetic dipole moment, angular momentum and gyromagnetic ratio. Biot and Savart's law, Ampere's law, magnetization current, magnetization vector, magnetic permeability.

Electromagnetic induction, Faraday's law, electromotive force, Faraday's law Mutual and self inductance, Transformers, energy in a static magnetic field, Maxwell's displacement current, Maxwell's equations, Poynting vector.

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THERMODYNAMICS, KINETIC THEORY AND STATISTICAL PHYSICS

The laws of thermodynamics: The Zeroth law, first law of thermodynamics, internal energy as a state function, reversible and irreversible change, Carnot theorem and the second law of thermodynamics. Clausius theorem inequality, Entropy, Enthalpy, The thermodynamic scale of temperature, third law of thermodynamics.

Thermodynamic relationships, Maxwell's general relationships, Van der Waals gas, Thermodynamic potentials and equilibrium of thermodynamical systems, Blackbody radiation: Pure temperature dependence, Stefan-Boltzmann law, pressure of radiation, Special distribution of BB radiation, Wien's displacement law, Rayleigh-Jean's law, Planck's quantum postulates, Planck's law.

Maxwellian distribution of speeds in an ideal gas, distinction between mean, rms and most probable speed values, Doppler broadening of spectral lines, Transport phenomena in gases: Molecular collisions, mean free path and collision cross sections. Mean free path, Transport of mass, momentum and energy and interrelationship, dependence on temperature and pressure. Refrigeration cycles,

The statistical basis of thermodynamics: Probability and thermodynamic probability, principle of equal a priori probabilities, statistical postulates, Concept of Gibbs's ensemble, accessible and inaccessible states, Concept of phase space, canonical phase space, probability and entropy, Boltzmann entropy relation. Boltzmann canonical distribution law and its applications, law of equipartition of energy. Transition to quantum statistics: 'h' as a natural constant and its implications,

Bose-Einstein & Fermi-Dirac conditions, Concept of partition function, Derivation of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac Statistics. Application of BE statistics to black body radiation, Application of F-D statistics to free electrons in a metal.

WAVES, ACOUSTICS AND OPTICS

Waves in media: Speed of transverse waves on a uniform string, speed of longitudinal waves in a fluid, energy density and energy transmission in waves, typical measurements. Group velocity and phase velocity, Harmonics and the quality of sound. Reflection, refraction and diffraction of sound, principle of a sonar system, sound ranging.

Cardinal points of an optical system, thick lens and lens combinations, magnification, telescopic combinations, telephoto lenses, Monochromatic aberrations and their reductions, aplanatic points, oil immersion objectives, meniscus lens. Optical instruments: Entrance and exit pupils, need for a multiple lens eyepiece, common types of eyepieces. (Ramsdon and Hygen's eyepieces)

Interference of light: The principle of superposition, two slit interference, coherence requirement for the sources, thin films, Michelson interferometer, Fabry-Perot interferometer.

Fresnel half-period zones plates, Fraunhofer diffraction: Diffraction at a slit, half-period zones, phasor diagram and integral calculus methods. Diffraction gratings: Diffraction at N Parellel slits intensity distribution, plane diffraction grating, reflection grating and Fabry-Perot etalon. Double refraction and optical rotation: Refraction in uniaxial crystals, Phase retardation plates, double image prism, Rotation of plane of polarization, origin of optical rotation in liquids and in crystals.

Laser system: Purity of a spectral line, coherence length and coherence time, spatial coherence of a source. Einstein's A and B coefficients, Spontaneous and induced emissions, conditions for laser action, population inversion, Types of Laser: Ruby and, He-Ne and Semiconductor lasers. Application of lasers: Application in communication, Holography and non linear optics.

RELATIVITY, QUANTUM MECHANICS, ATOMIC MOLECULAR AND NUCLEAR PHYSICS

Reference systems, inertial frames, Galilean invariance and conservation laws, propagation of light, Michelson-Morley experiment, Postulates for the special theory of relativity, Lorentz transformations, length contraction, time dilation, velocity addition theorem, variation of mass with velocity, mass-energy equivalence, particle with zero rest mass, Compton effect.

Quantum theory, photoelectric effect. Wave-particle duality and uncertainty principle: de Broglie's hypothesis for matter waves: the concept of wave and group velocities, evidence for diffraction &

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interference of particles, Davisson and Germer's experiment, Consequence of de Broglie's concepts, hydrogen atom, energies of a particle in a box, wave packets.

Quantum Mechanics : Schrodinger's equation, operators, expectation values, transition probabilities, applications to particle in a one and three dimensional boxes, harmonic oscillator in one dimension, reflection at a step potential, transmission across a potential barrier, Hydrogen atom and quantum numbers.

Spectra of hydrogen, deuterium and alkali atoms, selection rules, Discrete set of electronic energies of molecules, quantization of vibrational and rotational energies, determination of inter nuclear distance, pure rotational and rotation vibration spectra. Dissociation limit for the ground and other electronic states, transition rules for pure vibration and electronic vibration spectra. Raman Effect, Stokes and anti-Stokes lines, complimentary character of Raman and infrared spectra,

Interaction of charged particles and neutrons with matter, working of nuclear detectors, G-M counter, proportional counter and scintillation counter, cloud chambers, spark chamber, emulsions, Structure of nuclei, deuteron binding energy, p-p and n-p scattering and general concepts of nuclear forces, Beta decay, alpha decay and continuous and discrete spectra. Nuclear reactions.

SOLID STATE PHYSICS, ELECTRON DEVICES & PASSIVE CIRCUITS

Amorphous and crystalline solids, seven crystal system, Cubic lattices, Crystal planes, Miller indices, X-ray diffraction, Bragg's Law, Bonding in solids, classification, Cohesive energy of solid. Madelung constant, Specific heat of solids, classical theory (Dulong-Petit's law), Einstein and Debye theories, Vibrational modes of one dimensional monoatomic lattice, Dispersion relation, Brillouin Zone.

Free electron model of a metal, Density of states, Fermi Energy, Energy bands in a solid (Kronig-Penny model without mathematical details), Metals, Insulator and Semiconductors. Hall Effect, Dia, Para and Ferromagnetism, Langevin's theory of dia and para-magnetism, Curie- Weiss's Law, B-H curve and Hysteresis loss, Intrinsic semiconductors, carrier concentration in thermal equilibrium, Fermi level, Impurity semiconductor, donor and acceptor levels, Diode equation, junctions, junction breakdown, Depletion width and junction capacitance, abrupt junction, Tunnel diode, Zener diode. Light emitting diode, solar cell, bipolar transistors, pnp and npn transistors, characteristics of transistors, different configurations, current amplification factor, FET.

Half and full wave rectifier, rectifier efficiency ripple factor, Bridge rectifier, Filters, Inductor filter, T and N filters, Zener diode, regulated power supply, Applications of transistors, Bipolar Transistor as amplifier, Single stage and CE small signal amplifiers, Emitter followers, Transistorized power amplifier, Transistor as oscillator, Wein-Bridge Oscillator and Hartley oscillator.

MOS Devices, Basic construction of MOSFET and its working Physical explanation of the characteristics curve enhancement and depletion modes, MOSFET Parameters.

Basic idea of the impedance of L, C and R, representation of L and C in presence of loss (non ideal), Transformer and its equivalent circuit, mutual inductance, qualitative idea of magnetic core, Qualitative idea of Steady State and transient response. Network analysis (resistive and reactive), Network definition, loop and nodal analysis, principle of duality, reduction of complicated network, T and Pi form, conversion between T and Pi sections, superposition theorems, Norton's theorem, maximum power transfer theorem, Definition of Z, Y, H, G, Transmission (A, B, C, D parameters) for two port networks, inter-relationship of these parameters.

LINEAR ACTIVE CIRCUITS

Characteristic curves of bipolar transistors, determination of load line (static), active, Cut off and saturation regions, dynamic load lines. Biasing (fixed and self) of a transistor circuit, thermal instability of bias, transfer curves showing dependence of I_E on V_{BE} , $I_{C O}$ and β , $I_{C O}$ and V_{BE} , derivation of stability factors, S' and S'' .

Transistor circuit as a two port network, small signal active circuit, hybrid model of a CE transistor circuit and its equivalent, similarity in the small signal amplifiers using JFET and BJT, derivation of voltage and

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current gains, input impedance and output impedance RC coupled amplifier and derivation of half power points for its frequency response, idea of bandwidth.

Parallel resonant circuit, its quality factor and frequency response, basic circuits for tuned amplifiers, equivalent circuit of a single tuned transistor amplifier and determination of its gain and bandwidth (for CE case), idea of cascading of tuned amplifiers, Class A, Class B and Class C amplifiers, Power amplifiers, push pull amplifiers.

Feedback in amplifiers, advantage of negative feedback in amplifiers, voltage and current feedback transistor amplifiers, positive feedback, Barkhausen criterion for self sustained oscillations, Analysis of LC and Phase shift oscillators, Working of Hartley, Colpitt and Wein bridge Oscillators. Operational amplifiers : requirements of an ideal Op-Amp, Op-Amp basic idea of common mode gain, difference gain, common mode rejection ratio, application of Op-Amp as inverting and non inverting amplifier, adder, subtractor, integrator and differentiator.

DIGITAL ELECTRONICS

Number Systems and inter conversion, Binary additions, binary subtraction, 1's and 2's Complements, binary multiplication and division. BCD and Gray code. Logic Gates: OR, AND, NOT NAND, NOR, X OR X-NOR gates, positive and negative logic

Boolean Algebra : De Morgan's theorem, Laws and theorems of Boolean algebra, sum of product and product of sums simplification, equivalence between AND, OR AND NAND-NAND and equivalence between OR-AND, AND NOR-NOR networks, Karnaugh map simplification. Arithmetic circuits : Half and full adders, half and full subtractors, binary adders, 8421 adders, 2's complement adder Subtractor.

Logic families : Various logic families RTL, DTL, TTL, ECL, MOS, I²L, (MOS) and their characteristics, basic gates used in these families. Flip flop, D flip flop, JK flipflops, positive and negative edge triggered flip flops, JK master slave flip flop, idea of astable and monostable multivibrators.

Registers and counters : Data register, shift registers, synchronous counter, ripple counter, up-down counter, ring counter, decade counter. A/D and D/A converters: basic D/A converters, Ladder method, counter methods of A/D converter.

Memories: Volatile and Non-Volatile memories, ROM, PROM, EPROM, RAM, dynamic and static RAMS floppy disc. Microprocessor: Introduction to a microprocessor, and popular digital IC's of 8085 family. INTEL 8085-A-Architecture and pin out diagrams, The programme, CPU, Processing of instruction inside a CPU, Timing in CPU, CPU used in a system, Instruction set for 8085 Microprocessor.

ELECTRONIC INSTRUMENTS

Regulated Power Supplies: Power supply characteristics, Zener regulator, series voltage regulator, series regulator with pass transistor to large load currents, Shunt regulator, idea of Darlington pair, Regulator with Op-amp, inverting, non-inverting, Amplifiers, IC regulated circuits

CRO : Block diagram, basic operation, electro-static focusing, electrostatic deflection, screens for CRT, CRT circuits, Horizontal deflection system, Sweep generator, Synchronizing the wave, vertical deflection system, frequency and phase measurement, storage CRO

Signal Generators: Sweep frequency Generator, pulse and square wave generator, astable multivibrator, 555 timers for frequency generation, function generator.

Electronic Voltmeter, Direct Coupled amplifier and Chopper type D.C. amplifier, A.C. Voltmeter, true RMS responding Voltmeter, voltmeter sensitivity. Power meter: Single phase, double phase and three phase Watt-meter Watt hour meter.

Digital Voltmeter: LED's digital display seven segment display, integrating DVM, Ramp DVM, and Stair case Ramp, Successive approximation DVM, Sample and hold circuits.

Analog/Digital Multimeter, AC and DC measurement, A/D and D/A converter, Frequency counter, universal counter, measurement modes

POWER ELECTRONICS, MICROPROCESSORS PROGRAMMING AND CS & IT FUNDAMENTALS

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Semiconductor power Devices: Power Diodes, Power Transistors, Uni-junction Transistor, Silicon controlled Rectifier, Diac and Triac, UJT as a Relaxation Oscillator, Triac as a switch.

8085 up Instruction Sets and Programming of 8085 microprocessor : Logic 8 bit Instructions of 8085 Data Transfer (copy) Instructions, MOV, Arithmetic Instructions (ADD, ADI, SUB, SUI, INR, DCR), Logic operations : ANA, ANI, ORA, ORI, XRA, XRI, Branch Operations : Unconditional and Conditional Jump Instruction, Rotate Operations : RLC, RAL, RRC, RAR, 16 Bit Arithmetic and Logical operations.

Programmable Interface Devices: Internal Architecture and pin out diagram of the 8155/8156 and 8355/8755 Multipurpose Programmable Devices, the 8279 Programmable keyboard/display interface.

Interfacing Data Converters: Digital to Analog (D/A) converter, Analog to Digital (A/D) converter.

Computer science-Introduction to computer organization, time sharing and multi programming systems, window based word processing packages, MS Word, Introduction to C programming and application to simple problems of arranging numbers in ascending / descending orders; sorting a given data in an array, solution of simultaneous equation.

Information Technology:

Information theory - Introduction information in communication system, measurement of information, the binary digit (bit). Data sets and their connection requirements, Modem: Classification, modes of modem operation, modem interconnection, modem data transmission speed. Internet basics: Basic information about Http, WWW, HTML, shell and TCP/IP account, Browsers - Netscape and Internet explorer, e-mail.

Communication Technology: LAN, WAN and MAN, wireless network, Internetwork, network topology, OSI and TCP/IP reference models, comparison between them and their criticism. Details about Physical layer: magnetic media, twisted pair (UTP and STP), coaxial cable, fiberoptic cable Basic idea about ISDN.

COMMUNICATION SYSTEMS

Analysis of passive filters (low pass, band pass and high pass), Noise : Thermal noise, shot noise, Partition noise, low frequency and transit time noise, signal to noise ratio, noise factor, noise temperature.

Modulation : Amplitude modulation; frequency spectrum of AM, average power average voltage, modulation index for multiple sine waves, linear and square modulators, collector modulator, balance modulator, single side band (SSB) generation/method, diode detector, advantages and disadvantages of SSB over DSB AM : SSB detection, AM Transmitters, Super heterodyne receiver,

Angle Modulation: Elements of frequency and phase modulation frequency spectrum of FM waves, comparisons of FM and AM; Angle - Modulator circuits, varactor diode and FET modulators; Foster Seelay discriminator and ratio detector.

Pulse Modulation : Pulse Modulation, pulse transmission, pulse amplitude modulation, time division multiplexing, pulse time modulation, pulse width and pulse position modulation, digital filtering, pulse code modulation: PCM transmission and receiving circuits.

Television engineering : Scanning process, characteristics of human eye, aspect ratio, persistence of vision and flicker, resolution and video bandwidth, interlaced scanning, blanking, synchronizing and equalizing pulses, Vestigial side band signal, standard channel characteristics, TV camera tubes Image orthicon and vidicon, TV transmitter and receiver. Three colour system, luminance and chrominance signal, colour TV camera, colour picture tubes.

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