GROUP-14

Inspector Legal Metrology- (Level- B.Sc. with Physics/ Dip in Engineering.)

1) General awareness, Reasoning, Mathematics, Science, History including Haryana related history, current affairs, literature, Geography, Civics, Environment, Culture etc.- (**Weightage 20%)**

2) Computer terminology, Fundamentals, word software, excel software, Power point, internet, web browsing, Communication, emails, downloading and uploading data on websites etc**. -**

(Weightage 10%)

3) Subject related syllabus- **(Weightage 70%)**

Mechanics

Dimensional analysis. Newton's laws of motion and applications, variable mass systems, projectiles. Rotational dynamics, scalar and vector quantities, kinetic energy, angular momentum, theorems of moment of inertia and calculations in simple cases. Gravitational potential and intensity due to spherical objects. Central forces and Kepler's problem, escape velocity and artificial satellites, Special relativity and Lorentz transformation-length contraction, time dilation, mass-energy relation.

Properties of Matters:

Elasticity: small deformations, Hooke's law, elastic constants for an isotropic solid, inter relations of elastic constants, torsion of a cylinder, Kinematics of moving fluids, rate of flow, equations of continuity, Bernoulli's theorem, viscous fluids, viscosity and coefficient of viscosity, streamline 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, angle of contact, capillarity, determination of surface tension by capillary rise method.

Oscillation and Waves:

Differential equation of Harmonic oscillations and its solution, kinetic and potential energy, examples of simple harmonic oscillations, spring and mass system, simple and compound pendulum. Superposition of two simple harmonic motions of the same frequency, superposition of two mutually perpendicular simple harmonic vibrations of the same frequency,Free and forced vibration: conditions of maximum amplitude, resonance and condition of resonance, sharpness of resonance, Transverse and longitudinal waves, reflection of waves.

Kinetic Theory and Thermodynamics

Kinetic interpretation of temperature, estimation of rms speeds of molecules, equipartition of energy, specific heat of mono, di and tri-atomic gases, Van der Waals gas, equation of state, nature of van der Waals forces, comparison with experimental P-V curves, The critical constants, Reduced equation of state, Thermal equilibrium, heat, internal energy and work, First law of thermodynamics, Reversible and irreversible changes, Carnot cycle and its efficiency, Carnot theorem and the second law of thermodynamics, Entropy, principle of increase of entropy, The thermodynamic scale of temperature; its identity with the perfect gas scale, Impossibility of attaining the absolute zero; third law of thermodynamics.

Electrostatics &Electromagnetism:

Gauss's law and its application for finding E for symmetric charge distributions, electrostatic field energy, force per unit area on the surface of a conductor in an electric field, Dielectrics, Parallel plate capacitor with a dielectric, dielectric constant. Alternating currents: complex impedance, reactance, LCR series and parallel circuits, resonance, Q factor, power dissipation and power factor. Electromagnetic Induction: Faraday's laws (integral and differential form), Displacement current, Modified Ampere's law and its application.

Magnetism:

Laplace ‘s and Poisson’s equations; Boundary value problems and their solutions; Maxwell’s equations; application to wave propagation in bounded and unbounded media; Transmission lines: basic theory, standing waves, matching applications, misconstrue lines. Basics of wave guides and resonators; Elements of antenna theory.

Optics:

Thick lens: Cardinal points, image formed by thick lens, relation between the distances of cardinal points, object and image-distance from principal planes, cardinal points of Ramsden and Huygens’ eyepieces. Principle of superpositions, Young's two-slit interference, Production of Interference by Fresnel biprism, determination of wavelength of light, theory of Newton’s ring and its application. Michelson interferometer, its application for precision determination of wavelength, wavelength difference and the width of spectral lines. Polarization of light: production of polarized light by reflection and refraction. Laser system: Einstein’s A and B coefficients, spontaneous and induced emissions, conditions for laser action, population inversion.

Atomic, Nuclear Physics:

Bohr’s theory of H-like atoms, Pauli’s exclusion principle, quantum number for atomic orbitals and degeneracy. Positive rays: Thomson’s parabola method, isotopes, isobars, Aston’s mass spectrograph, Bainbridge mass spectrograph, General properties of Nucleus: Nuclear size, nuclear mass, nuclear density, nuclear charge, Binding energy, stability of nucleus and binding energy, packing fraction. Nuclear fission: Discovery, energy released in fission, secondary neutrons and their importance, multiplication factor, chain reaction. Nuclear fusion: origin of stellar energy, calculation of fusion energy.

Solid State Physics:

Fundamental types of lattices in 2 and 3-dimensions, Crystal planes, simple crystal structure: NaCl and Diamond structure, Miller indices, coordination numbers, atomic packing factor. X-ray diffraction by crystal planes, Bragg’s law of diffraction, Laue's equations, Reciprocal Lattice and lattice vectors, properties of reciprocal lattice vectors, Relation between direct and reciprocal lattice vectors. Thermal properties: Specific heat of solid, Deduction of Dulong and Petit law from the harmonic oscillator concept, Einstein’s theory of specific heat and its failures, Debye law of specific heat, Thermal conductivity, Weidman-Franz law, Fermi energy, Energy levels and density of states in one and three dimensions.

Electronics:

Semiconductors: Intrinsic semiconductors, electrons and holes, Doping; impurity states, n and p type semiconductors, conductivity, mobility, Hall effect, Hall coefficient. p-n junction diode, majority and minority carriers, Zener diode, Diode rectification, ripple factor, Zener diode as a voltage stabilizer, characteristics of a transistor in CB, CE and CC mode, Logic gates and truth tables, Three terminal devices (UJT and FETs): (i) UJT: its Characteristics and Equivalent Circuit, Relaxation Oscillator, (ii) JFET: Its Characteristics and Equivalent Circuit.

Quantum Mechanics:

Origin of the quantum theory: Failure of classical physics to explain the phenomena such as black-body spectrum, photoelectric effect, Planck’s radiation law. Wave-particle duality and uncertainty principle, de Broglie’s hypothesis for matter waves; the concept of wave and group velocities, evidence for diffraction and interference of particle, experimental demonstration of matter waves, Heisenberg’s uncertainty relation for p and x, its extension to energy and time, Consequence of the uncertainty relation: gamma ray microscope, diffraction at a slit. Schrodinger equations, physical meaning of ψ , conditions to be satisfied by Schrodinger equation as an operator equation, Particle in a box with rigid walls, concept of a potential well, wave functions and energies for the ground and excited states; quantization of energy.

Classical Mechanics:

Reduction of two body problem to one body problem, reduced mass, Motion under a central force, Kepler’s law, Deduction of Newton’s laws of gravitation from Kepler’s laws of planetary motion and Kepler’s laws form Newton’s laws. Constraints and generalized co-ordinates, Principle of virtual work, D’Alembert’s principle, Lagrangian and Lagrange’s equations for simple pendulum, Keplerian motion.

Hamilton's canonical equation from Lagrange's equation, Hamilton's equation of motion for a simple pendulum.

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

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 behaviour of diodes and transistors. Small signal amplifiers, biasing circuits, frequency response and improvement, multistage amplifiers and feed-back amplifiers, D.C. amplifiers, coupling methods, push pull amplifiers, operational amplifiers, wave shaping circuits, Multivibrators and flip-flops and their applications. Digital logic gage families, universal gates combinational circuits for arithmetic and logic operational, sequential logic circuits. Counters, Registers, RAM and ROMs.

Analog Electronic Circuits:

Transistor biasing and stabilization. Small signal analysis. Power amplifiers. Frequency response. Wide banding techniques. Feedback amplifiers. Tuned amplifiers. Oscillators. Rectifiers and power supplies. Op Amp PLL, other linear integrated circuits and applications. Pulse shaping circuits and waveform generators.

Digital Electronic Circuits:

Transistor as a switching element; Boolean algebra, simplification of Boolean functions, Karnaguh map and applications; IC Logic gates and their characteristics; IC logic families: DTL, TTL, ECL, NMOS, PMOS and CMOS gates and their comparison; Combinational logic Circuits; Half adder, Full adder; Digital comparator; Multiplexer Demultiplexer; ROM and their applications. Flip flops. R-S, J.K, D and T flip-flops; Different types of counters and registers Waveform generators. A/D and D/A converters. Semiconductor memories.

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, CTOs, power MOSFETs; Basics of ICs – bipolar, MOS and CMOS types; basic to Opto-Electronics.

Fluid Mechanics:

Properties and classification of fluids, Manometry, forces on immersed surfaces, Centre of pressure, Buoyancy, Elements of stability of floating bodies. Kinematics and Dynamics. Irrotational and incompressible. Inviscid flow. Velocity potential, Pressure field and Forces on immersed bodies. Bernoulli's equation, fully developed flow through pipes, Pressure drops calculations, Measurement of flow rate and Pressure drop. Elements of boundary layer theory, Integral approach, Laminar and turbulent flows, Separations. Flow over weirs and notches. Open channel flow, Hydraulic jump. Dimensionless numbers, Dimensional analysis, Similitude and modelling. One-dimensional isentropic flow, Normal shock wave, Flow through convergent - divergent ducts, Oblique shockwave, Rayleigh and Fanno lines.

Engineering Materials:

Basic concepts on structure of solids. Crystalline materials. Defects in crystalline materials. Alloys and binary phase diagrams. Structure and properties of common engineering materials. Heat treatment of steels. Plastics, Ceramics and composite materials. Common applications of various materials, 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 an Electromechanical components, 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.

Electrical Circuits:

Circuit elements, Kirchhoff'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, three phase circuits, Two-port networks, Elements of twoelement network synthesis.

Important Note: The Weightage as mentioned against the syllabus is tentative & may vary.