

23. SYLLABI : NEE-II (PCM / PCB)

(Syllabi for Class -XIIPCM and PCB applicants seeking admission in Degree Module in Engineering & Technology and Degree Module in Forestry, respectively).

Full Marks : 150

Time: 3 Hours

SECTIONS :

Section-A	Physics	45 marks. (Common for Class -XII PCM as well as PCB Candidates)
Section-B	Chemistry	45 marks. (Common for Class -XII PCM as well as PCB Candidates)
Section-C	Mathematics	60 marks. (for Class -XIIPCM Candidates)
Section-C	Biology	60 marks. (for Class -XIIPCB Candidates)

Section-A PHYSICS

45 marks

Physical World and Measurement: Physics scope and excitement, physics, technology and society, Forces in nature, Conservation laws, Examples of Gravitational, electromagnetic and Nuclear forces from daily-life experiences (qualitative only). Need for measurement, Units of measurement, systems of units, SI units, Fundamental and derived units, length, mass and time measurement, Accuracy and precision of measuring instruments. Errors in measurement, significant figures. Dimensions of Physical quantities. Dimensional analysis and application. Elementary concept of differentiation and integration for describing motion.

Kinematics: Uniform motion in a straight line, Position time graph, speed and velocity, Uniform and non-uniform motion, average speed and instantaneous velocity . Uniformly accelerated motion, velocity time graph, relations for uniformly accelerated motion (Graphical method). Scalar and vector quantities, position and displacement vectors, Equality of vectors, multiplications of vectors by real number, Addition and subtraction of vectors, Unit vector, Resolution of a vector in a plane. Rectangular components, Scalar and Vector products of two vectors, vectors in 3 dimensions (elementary idea only) Motion in a plane, Uniform velocity and uniform acceleration, projectile motion, uniform circular motion.

Laws of Motion: Force and inertia, Newton's first law of motion, Momentum, Newton's second law of motion, Impulse , Newton's third law of motion, conservation law of linear momentum and its application, Equilibrium of concurrent forces, Friction, static and dynamic friction, laws of friction, rolling and sliding friction, lubrication. Dynamics of uniform circular motion, centripetal force, Vehicle on a level road, Vehicle on a banked road. Inertial and non-inertial frames (Idea only).

Work, Energy and Power: Work done by a constant force and variable force, kinetic energy, Potential energy, work-energy theorem, power. Potential energy of a spring, conservative and non-conservative forces, conservation of mechanical energy (kinetic and potential energies), collisions, Elastic and inelastic collision in 1 dimension and 2 dimensions. Different forms of Energies in nature, Mass-Energy equivalence (Qualitative Idea).

Motion of system of particles and Rigid Body: Centre of mass of two particle system, generalization to N-particles, momentum conservation and center of mass motion, Application to familiar systems, Centre of mass of a rigid body.

Gravitation : The universal law of Gravitation, Gravitational constant, Acceleration due to gravity and its variation with altitude, latitude, depth and rotation of earth, Mass of the earth, Gravitational potential energy near the surface of earth, gravitational potential, Escape Velocity. Orbital Velocity of a Satellite. Weightlessness, Motion of Satellites, geostationary and polar satellites, Kepler's laws of planetary motion. Proof of second and third law, (for circular orbit) Inertial and gravitational mass. Moment of force, torque, angular momentum, Physical meaning of angular momentum, conservation of angular momentum with some examples (Planetary motion). Equilibrium of rigid bodies, rigid body rotation and equation of rotational motion. Moment of Inertia & its physical significance, radius of gyration, parallel and perpendicular axis theorem (statement only) M.I. of circular ring, disc, cylinder and thin straight rod. Rolling of a cylinder without slipping. Examples of binary system in nature (Binary Stars, Earth-moon system, diatomic molecules).

Mechanics of Solids and Fluids: States of matter, inter atomic and inter molecular forces.

a) **Solids :** Elastic behavior, stress-strain relationship, Hooke's law, Young's modulus, bulk modulus, modulus of rigidity & some practical examples.

b) **Fluids:** Pressure due to fluid column, Pascal's law and its application (hydraulic lift and brakes) Effect of gravity on fluid pressure . Buoyancy, flotation, and Archimedes principle, Viscosity, Stoke's law, terminal velocity, stream line flow, trubulent flow. Reynold's number. Bernoulli's theorem and its applications.

c) Surface energy and surface tension, angle of contact, application of surface tension, excess pressure inside a liquid drop and bubble, capillary rise and action of detergent.

Heat and Thermodynamics: Kinetic theory of gases-assumptions, concept of pressure, kinetic energy and temperature, r.m.s. speed, degree of freedom, law of equipartition of energy (statement only), mean free path and Avogadro's number.

Thermal equilibrium and temperature (Zeroth law of thermodynamics) Heat, work and internal energy, thermal expansion-thermometry. First law of thermodynamics, specific heat, specific heat of gas at constant volume and pressure (mono atomic, diatomic gases). Specific heat of solids (Dulong and Petits' law).

Thermodynamic variables and equation of state, phase diagram; ideal gas equation, isothermal and adiabatic processes, reversible and irreversible processes carnot's engine and refrigerator or heat pump. Efficiency and co-efficient of performance, second law of thermodynamics (statement only); and some practical applications.

Transfer of heat-Conduction, convection and radiation. Thermal conductivity of solids, Black body radiation, Kirchhoff's laws, Wein's displacement law, Stefan's law (statement only) Newton's law of cooling, solar constant and determination of surface temperature of sun using Stefan's law.

Oscillations: Periodic motion- period, frequency, displacement as a function of time and periodic functions. Simple Harmonic Motion (SHM) and its equation, Expression for velocity and acceleration of SHM. Oscillations of a spring, restoring force and force constant, Energy in SHM-Kinetic and potential energies, Simple pendulum- derivation of its time period, Free, forced and damped oscillations (qualitative idea only), resonance, coupled oscillations.

Waves: Longitudinal and transverse wave, wave motion, Displacement relation for progressive wave. Principle of superposition of waves, Reflection of waves, Standing waves in strings and pipes, fundamental and higher harmonics, Beats, Doppler's effect, speed of sound in media.

Electrostatics: Frictional electricity, charges and their conservation, coulomb's law, Forces between two point electric charges. Forces between multiple electric charges; Superposition principle and continuous charge distribution. Electric fields and its physical significance, electric field due to a point charge, electric field lines, electric field due to a dipole and behavior of a dipole in a uniform electric field. Electric potential-physical meaning, potential difference, electric potential due to a point charge, a dipole and system of charges; Equipotential surfaces, Electrical potential energy of a system of two point charges and of electric dipole in an electrostatic field. Electric flux, statement of Gauss's theorem and its applications to find field due to infinitely long straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell. Conductors and insulators, presence of free charges and bound charges inside a conductor, Dielectrics and electric polarization, general concept of a capacitor and capacitance : Combination of capacitors in series and parallel, energy stored in a capacitor, capacitance of a parallel plate capacitor with and without dielectric medium between the plates; Van de Graff generator.

Current Electricity: Electric current, flow of electric charge in a metallic conductor, drift velocity and mobility and their relation with electric current, ohm's law, electrical resistance, V-I characteristics, Exception, of ohm's law (Non-linear V-I characteristics), Electrical resistivity and conductivity, classification of materials in terms of conductivity; Superconductivity (elementary idea); Carbon resistors, colour code for carbon resistors, combination of resistances- series and parallel.

Temperature dependence of resistance, Internal resistance of a cell, Potential difference and e.m.f. of a cell, combinations of cells in series and in parallel. Kirchhoff's laws - illustration by simple application. Wheatstone bridge and its Applications for temperature Measurements. Metre bridge-special case of whetstone's bridge. Potentiometer- principle and application to measure potential difference, and for comparing e.m.f. of two cells.

Electric power, thermal effects of current and Joule's law, Chemical Effects of Current: Faraday's laws of electrolysis; Electrochemical Cells- Primary (Voltaic Lechlanche, Dry Daniel,) and secondary-

rechargeable cells (lead accumulators, alkali accumulators) solid state cells. Thermoelectricity- origin, elementary idea of Seebeck effect; Thermocouple. Thermo e.m.f. neutral and inversion temperatures. Measurement of temperature using a thermocouple.

Magnetic effects of current & magnetism: Concept of magnetic field, Oersted's experiment, Biot-Savart law, magnetic field due to an infinitely long current carrying straight wire and a circular loop: Ampere's circuital law and its application to straight and toroidal solenoids; Force on a moving charge in uniform magnetic and electric fields, cyclotron; Force on a current carrying conductor in a uniform magnetic field, Forces between two parallel current-carrying conductors, definition of ampere. Torque experienced by a current loop in a uniform magnetic field, moving coil galvanometer-its current sensitivity and conversion to ammeter and voltmeter. Current loop as a magnetic dipole and its magnetic dipole moment, magnetic dipole moment of a revolving electron, Magnetic field intensity due to magnetic dipole (bar magnet) along the axis and perpendicular to the axis; Torque on a magnetic dipole (bar magnet) in a uniform magnetic field; Bar magnet as an equivalent solenoid, Magnetic field lines. Earth's magnetic fields and magnetic elements: Para, dia and ferromagnetic substances with examples. Electromagnets and permanent magnets.

Electromagnetic Induction & Alternating currents: Electromagnetic Induction, Faraday's Laws, Induced e.m.f. and current, Lenz's law, Eddy currents, Self and mutual inductance. Alternating currents peak and r.m.s. values of Alternating current/voltage, reactance and impedance; LC oscillations, LCR series circuit (Phasor diagram) Resonant circuits and Q-factor, Power in AC circuits, Wattless current. AC generator and transformer.

Electromagnetic Waves: Electromagnetic waves and their characteristics (qualitative idea only); Transverse nature of electromagnetic waves.

Electromagnetic spectrum (Radio-microwaves, infrared, optical, Ultraviolet, gamma rays) including elementary facts about their uses, Propagation of electromagnetic waves in atmosphere.

Optics : Refraction of light, total internal reflection and its application, spherical lenses, thin lens formula, lens maker's formula; Magnification, Power of a lens, combination of thin lenses in contact; Refraction and dispersion of light due to a prism, Scattering of light. Blue colour of the sky and reddish appearance of the sun at sun-rise and sun set.

Optical Instruments – Compound Microscope, astronomical telescope (refraction and reflection type) and their magnifying powers.

Wave front and Huygens's principle; Reflection and refraction of plane wave at a plane surface using wave fronts (qualitative idea); Interference- Young's double slit experiment and expression for fringe width, Coherent sources and sustained interference of light; Diffraction due to a single slit, width of central maximum, difference between interference and diffraction.

Resolving power of microscope and telescope, Polarization-plane polarized light, Brewster's Law, Use of plane polarized light and Polaroid.

Dual Nature of Matter and Radiation: Photo-Electric effect, Einstein's Photo-electric equation, Particle nature of light, Photo Cell, Matter waves, Wave nature of particles, De-Broglie relation, de Broglie wave length of an electron. Davisson-Germer Experiment.

Atomic Nucleus: Alpha-particle scattering experiment, size of the nucleus, composition of the nucleus, protons and neutrons, Nuclear instability- Radioactivity-Alpha, Beta and Gamma particles/rays and their properties, radioactive decay law, simple explanation of decay, beta-decay and gamma-decay. Mass-energy relation, mass defect, binding energy per nucleon, its variation with mass number. Nature of nuclear forces, nuclear reaction, Nuclear fission and Nuclear fusion.

Solid and Semi-conductor Devices: Energy bands in solids (qualitative idea only), difference between metals, insulators and semiconductors using band theory; intrinsic and extrinsic semi-conductors, p-n junction, semi-conductor diode-characteristics in forward and reverse bias, diode as a rectifier, solar cell, photodiode. LED, Zener diode as a voltage regulator, Junction transistor, transistor action, characteristics of a transistor. Transistor as an amplifier (common emitter configuration) and oscillator. Logic gates (OR, AND, NOT, NAND and NOR); Elementary ideas about IC.

SECTION-B CHEMISTRY

45 marks

Some Basic concepts of chemistry: Nature of matter, properties of matter and their measurements, Law of Chemical combination, Dalton's Atomic Theory, Atomic and molecular masses, Mole concept, Stoichiometry and stoichiometric calculations.

Structure of Atoms and Chemical Bonding: Constituent of the atom, electronic structure of atom, understanding electron behavior, Bohr's model of hydrogen and hydrogen like atoms, spectrum of hydrogen, Dual behavior of matter, de Broglie equation, Heisenberg's uncertainty principle; Quantum numbers, shapes of orbital, Aufbau principle, Pauli's exclusion principle, Hund's rule of maximum multiplicity; Electronic configuration of elements up to atomic numbers 30. Chemical bonding: Lewis structure, Hybridization and VSEPR theory with reference to BeCl_2 , BF_3 , CH_4 , CCl_4 , NH_3 , H_2O , NH_4^+ , H_3O^+ , PCl_5 , SF_6 , C_2H_4 and C_2H_2 . Molecular orbital theory with reference to simple homodiatomic molecules up to atomic number 10. Hydrogen bond. Dipole moment in simple molecules.

States of Matter: The gaseous state: Kinetic molecular theory of ideal gases. Laws governing the ideal behavior of gases, deviation from the ideal behavior; van der Waals equation of state for real gases. Concept of critical constants, Liquefaction of gases.

Solid State: Structure of simple ionic compounds, Close-packed structure, ionic radii; Silicates, Imperfections in solids, properties of crystalline solids and amorphous solids.

Solutions: Types of solution, Vapor pressure of solution and Raoult's law, Ideal and non-ideal solutions. Colligative properties, Abnormal molecular masses.

Chemical Thermodynamics: Some basic concepts; Energy changes during a chemical reaction, Internal energy and Enthalpy. Enthalpy of reaction, First law of thermodynamics, Concept of Entropy and Free energy, Spontaneity of a process, Second and Third law of thermodynamics.

Chemical Equilibrium: Equilibria involving physical changes and chemical systems, Law of Mass action and its application to equilibrium. Le-Chatelier's principle and its applications. Ionic Equilibria; Ostwald's dilution law; Arrhenius, Bronsted-Lowry and Lewis concept of acids and bases. pH scale, Buffer solutions and Solubility product.

Chemical Kinetics: Rate of reaction, Instantaneous rate of a reaction, Molecularity and order of a reaction, Factors affecting the rate of a reaction, Elementary and complex reactions, Determination of the order of a reaction, Dependence of reaction rate on temperature and catalyst, Photochemical reactions, Mechanism of a reaction.

Surface Chemistry: Adsorption, Colloidal solutions, Emulsions. Homogeneous and heterogeneous catalysis.

Redox Reactions: Oxidation and reduction as an electron transfer process, Oxidation number, balancing of redox equations.

Electrochemistry: Electrolytic conductance, Equivalent and molar conductivities, Galvanic cell, Electrode potential and EMF of a Galvanic cell, Dependence of EMF on concentration and temperature Electrochemical cell and free energy, Electrolysis, Quantitative aspect of electrolysis, Faraday's Laws, and Criteria for product formation; Some commercial batteries, Corrosion.

s-Block Elements: General trends, characteristics of compounds of Alkali and Alkaline earth metals. Anomalous behaviour of Lithium and Beryllium. Some important compounds of Sodium and Calcium. Chemistry of Hydrogen, Water and Hydrogen peroxide.

p-Block Elements: General trends. Anomalous behaviour of Boron and Carbon. Allotropy: Different allotropes of Carbon, Sulphur, Phosphorus, and Tin. Chemistry of some important compounds of Boron, Carbon, Silicon, Nitrogen, Phosphorus, Oxygen, Sulphur, and Halogens. Characteristics of Group-18 elements, and Chemistry of Xenon. Metallurgy of Aluminium.

d- & f-Block Elements: General trends, Characteristic properties of transition and inner transition elements. General properties of first row transition metal compounds. Metallurgy of Iron and Copper. Manufacture of steel, Chemistry of some heavy metals like Silver, Gold, Zinc, Mercury, and Compounds such as Potassium permanganate and Potassium dichromate.

Co-ordination and Organo-metallic Compounds: Co-ordination compounds, Isomerism and bonding in co-ordination compounds; Stability of co-ordination compounds in solution; Importance of co-ordination compounds. Organo-metallic compounds.

Organic Chemistry: Classification and nomenclature of organic compounds, Isomerism and stereochemistry. Fundamental concepts in organic reaction mechanism, Methods of purification; Qualitative and quantitative analysis of organic compounds; Modern methods of structure elucidation.

Hydrocarbons: Preparation and properties of alkanes, alkenes and alkynes; Aromatic hydrocarbons, aromaticity. Preparation, properties and structure of Benzene.

Organic compounds with functional group: General methods of preparation, physical and chemical properties and important uses of haloalkanes, haloarenes, polyhalogen compounds, alcohols, phenols, ethers, aldehydes, ketones, carboxylic acids and derivatives of carboxylic acids, cyanides, isocyanides, amines, nitro and azo compounds.

Polymers: Nomenclature and classification of polymers, Types of polymerization, Molecular mass of polymers; Some commercially important polymers.

Bio-molecules: Structure and function of carbohydrates, proteins, nucleic acids, lipids and vitamins.

Nuclear Chemistry: Discovery of radioactivity and nature of radiation from radio active substances; Chemical equations for nuclear changes, Radioactive series, Rate of radioactive decay, Artificial transmutation radioactivity, Synthetic elements, Nuclear fission, Nuclear fusion. Applications of radioactivity and radio-isotopes.

Chemistry in Everyday life: Dyes, Chemicals in medicines, Chemistry of rocket propellants, Chemicals in food, Soaps and Detergents.

SECTION-C MATHEMATICS (for PCM Candidates)

60 marks

Algebra:

Sets: Sets and their representations, finite and infinite sets, subsets, empty or null set, universal set, equal sets, power set and complement of a set, union and intersection of sets and their algebraic properties, difference of sets, Venn diagrams, application of sets.

Relations and functions: ordered pairs, Cartesian product of sets, relations, domain, co-domain and range, into and onto functions, one one into and one one onto functions, constant function, identity function, composition of functions, invertible functions, Binary operations.

Complex Numbers: Complex number in the form $(a+ib)$, representation of complex numbers by points in plane, Argand diagram, algebra of complex numbers, real and imaginary parts of a complex number, triangle inequality, modulus and argument (or amplitude) of a complex number, conjugate, square root of a complex number, cube root of unity, polar representation of a complex number.

Theory of quadratic equation: Solution of a quadratic equation in the complex number system by (i) factorization (ii) using formula, relation between roots & coefficients, the nature of roots, formation of quadratic equations with given roots, Symmetric functions of roots, Equations reducible to quadratic forms.

Sequences and series: Sequence and examples of finite and infinite sequences, Arithmetic progression (A.P.)- first term, common difference and nth term, sum to n terms of an A.P., Arithmetic mean (A.M.), insertion of A.M. between any two given numbers, Geometric progression (G.P.)-first term, common ratio and nth term, Sum to n terms and infinite number of terms of a G.P., recurring decimal numbers as G.P., Geometric Mean (G.M.) insertion of G.M. between any two given numbers, Harmonic progression, Harmonic mean(H.M),relationship among A.M., G.M. and H.M, arithmetico-geometric series, special cases of $\sum n$, $\sum n^2$, $\sum n^3$, exponential series concept of e as the sum of an infinite series, proof of $2 < e < 3$, exponential function (e^x) as the infinite series, logarithmic series- infinite series for $\log_e(1+x)$, $\log_e(1-x)$ and related problems.

Permutations and combinations: Fundamental principle of counting, the factorial notation, Permutation as an arrangement, meaning of P (n,r), combination, meaning of C(n,r), application of permutations & combinations.

Mathematical Induction: The principle of mathematical Induction, simple applications.

Binomial theorems: Statement of binomial theorem, proof of the binomial theorem for positive integral exponent using the principle of mathematical induction, general and middle terms in binomial expansions,

Binomial theorem for any index (without proof), application of binomial theorem for approximation and properties of binomial coefficients.

Mathematical logic: Mathematical Logic statement, Venn diagrams, negation, basic logical connectives and compound statement including the negations, truth tables, duality algebra of statements and applications of logic in solving simple problems. Matrices and determinants: Types of matrices, Equality of matrices, operations of addition, scalar multiplication and multiplication of matrices, statements of important results on operations of matrices and their verification by numerical problems only, linear equations in matrix notation, determinants, determinant of a square matrix, properties of determinants, minors & cofactors of determinants, applications of determinants in (i) finding area of a triangle (ii) Solving a system of linear equations, Cramer's rule, transpose, adjoint and inverse of a matrix, consistency and inconsistency of system of linear equations, application of matrices in solving simultaneous linear equations in two or three variables.

Boolean Algebra: Boolean algebra as an algebraic structure, principle of duality, Boolean function, conditional and biconditional statements, valid arguments, switching circuits, application of Boolean algebra to switching circuits.

Trigonometry:

Trigonometric functions of sum and difference of numbers, Trigonometric functions of multiples and submultiples of numbers, conditional identities for the angles of a triangle, Solution of trigonometric equations, solution of triangles, concept of inverse trigonometric functions and their use to reduce expression to simplest form.

Vectors: Vectors & scalars, Magnitude and direction of a vector, types of vectors, position vector of a point dividing a line segment in a given ratio, components of a vector, addition of vectors, multiplication of a vector by a scalar, scalar (dot) product of vectors, projection of a vector on a line, Vector (cross) product of two vectors, application of dot & cross products in (i) finding area of a triangle and a parallelogram (ii) problems of plane geometry and trigonometry (iii) finding work done by a force (iv) vector moment of a vector about a point, scalar triple product and its applications, Moment of a vector about a line, co planarity of three vectors or four points using scalar triple product, vector triple product .

Coordinate Geometry: Two Dimension: (i) Area of a triangle, condition for the collinearity of three points, centroid and in-centre of a triangle, locus and its equation.

The straight line and pair of straightlines –Various forms of equations of a line, intersection of lines, angles between two lines, condition for concurrency of three lines, distance of a point from a line, coordinates of orthocentre and Circumcentre of a triangle, equation of family of lines passing through the point of intersection of two lines, homogeneous equation of second degree in x & y , angle between pair of lines through the origin, combined equation of the bisectors of the angles between a pair of lines, condition for the general second degree equation to represent a pair of lines, point of inter-section and angle between two lines represented by $S=0$ and the factors of S .

Circles: Standard form of the equation of a circle, general form of the equation of a circle, its radius and center, equation of a circle in the parametric form, equation of a circle when the end points of a diameter are given, points of inter- section of a line and a circle in the center at the origin and condition of a line to be tangent to the circle, length of tangent, equation of the tangent, equation of a family of circles through the inter- section of two circles, condition for two inter- secting circles to be orthogonal.

Conic sections- Sections of cones, equations of conic sections (parabola, ellipse, hyperbola) in standard forms, conditions for $y=mx+c$ to be a tangent and points of tangency.

Geometry of Three Dimension (3D): Coordinate axes, planes in three dimensional space, coordinates of a point in space, distance between two points, section formula, d.c'.s. and d.r'.s. of a line joining two points, projection of the join of two points on a given line, angle between two lines whose d.r'.s. are given, Cartesian and vector equation of a line through (i) a point and parallel to a given vector (ii) through two points, co- linearity of three points, coplanar & skew line, shortest distance between two lines, condition for the intersection of two lines, Cartesian & vector equation of a plane (i) when the normal vector and the distance of the plane from the origin is given (ii) passing through a point and perpendicular to given vector (iii) passing through a point and parallel to two given lines through the intersection of two other planes (iv) Containing two lines(v) Passing through three points, Angle between two lines (ii) two planes (iii) a line and a plane. Condition of co-planarity of two lines in vector and Cartesian form, Length of perpendicular of a point from a plane by both vector and Cartesian methods, vector and Cartesian equation of a sphere, its center and radius, diameter form of the equation of a sphere.

Calculus: Function, Limits and Continuity: Concept of real function, its domain and range, types of functions, limit of a function, meaning and related notations, left and right hand limits, fundamental theorems on limits, limit at infinity and infinite limits, continuity of a function (i) at a point (ii) over an open/closed intervals, Sum, product and quotient of continuous functions, continuity of special functions-polynomial, trigonometric, exponential, logarithmic, inverse trigonometric functions.

Differentiation: Derivative of a function, its geometrical and physical significance, Relationship between continuity and differentiability, derivative of some simple functions from first principle, derivative of sum, difference, product and quotient of functions, derivative of polynomial, trigonometric, exponential, logarithmic, inverse trigonometric and implicit functions, derivative of functions expressed in parametric form, chain rule and differentiation by substitution, Derivatives of second order.

Application of Derivatives: Rate of change of quantities, tangents and normals, increasing and decreasing functions and sign of the derivatives, maxima & minima, greatest and least values, Rolle's theorem and mean value theorem (without proof), curve sketching of simple curves.

Indefinite integrals: Integration as inverse of differentiation, properties of integrals, integration by substitution, by parts, partial fractions and their use in integration, integration of rational and irrational functions, integration of trigonometric functions of the type

$$\int \frac{dx}{a+b\cos x}, \int \frac{dx}{a+b\sin x} \text{ and } \int \sin^m x \cos^n x dx.$$

Definite Integrals: Definite integral as limit of a sum, fundamental theorems of integral calculus (without proof), evaluation of definite integrals by (i) substitution (ii) using properties of definite integrals, application of definite integrals in finding the areas bounded by a curve, circle, parabola and ellipse in standard form between two ordinates and x-axis, area between two curves (line and circle, line & parabola, line & ellipse).

Differential Equations: Definition, order and degree, general and particular solution, formation of a differential equation whose general solution is given, solution of differential equation by the method of separation of variables, homogeneous differential equations, linear differential equation of the type

$$\frac{dy}{dx} + py = Q(x) \text{ whose } p(x) \text{ \& } Q(x) \text{ are functions of } x, \text{ Solution of second order differential equations.}$$

Statics and Dynamics: Elementary Statics- Introduction, basic concepts, laws of mechanics, force, resultant of forces acting at point, parallelogram Law of forces, resolved parts of a force, equilibrium of a particle under three concurrent forces, triangle law of forces and its converse, Lami's theorem and its converse, two parallel forces, Like and unlike parallel forces, couple and its moment.

Elementary Dynamics: Basic concept. like displacement, speed, velocity, average speed, instantaneous speed, acceleration and retardation, resultant of two velocities, Motion of a particle along a line when moving with constant acceleration, motion of a particle under gravity, projectile motion, the path of a projectile, its horizontal range, velocity at any instant, greatest height and time of flight.

Probability: Random experiment and associated sample space events as subsets of sample space, occurrence of an event, impossible events, sure events, combination of events through the operations "and", "or", "not" and their set representation, meaning of equally likely outcomes, definition of probability of an event as the ratio of the number of favorable equally likely outcomes to the total number of outcomes, equally likely events, addition rule for mutually exclusive events, Conditional probability, independent-events, independent experiments, Calculation of probability of events associated with the independent experiments $P(A \text{ or } B)$, $P(A \text{ and } B)$, Baye's theorem and its application, recall of concept of random variables and its probability distribution, mean and variance of random variables, Binomial and Poisson's distributions, their mean, variance and application of these distributions in commerce and industry.

SECTION-C BIOLOGY (For PCB Candidates)

60 Marks

Origin and Evolution of life: Theories and evidences of origin of life, Concept of species, speciation and isolation; Homeostasis; Scope of biology; Classification-artificial, natural and phylogenetic; Binomial nomenclature; Status of bacteria and virus.

Cell biology : Ultra structure of cell; cell organelles and their function; Cell division; Karyotype analysis; Chromosomal basis and other patterns of inheritance; Linkages and crossing over; Mutation and chromosomal aberrations; Gene mapping; Human genetics; Structure of RNA and its role in protein synthesis; Gene expression and its regulation; Nuclear basis of differentiation and development; Oncogenes; DNA as a genetic material; Recombinant DNA technology; Gene bank; DNA fingerprinting; Genomics-principles and applications; Transgenic plants, animals and microbes.

Physiology of plants and animals: Plant water relations; Transpiration; Photosynthesis; Respiration, glycolysis, Krebs's cycle, compensation point, Respiratory Quotient; Food and Vitamins; Inter- and intra-cellular digestion; Role of hormones and enzymes in digestion; malnutrition; Respiration and circulation in animals; Blood, its composition and related disorder; Osmoregulation and excretion.

Reproduction and growth in plants and animals: Vegetative, micropropagation and sexual reproduction; Flowering-Photoperiodism, Vernalization; Pollination; Double fertilization; Parthenogenesis and Parthenocarpy; Reproduction in animal-embryonic development, growth, repair, aging and death; Movement and locomotion in plants and animals; Nervous coordination in animal; Phytochromes; seed germination; Role of growth regulators in seed dormancy.

Ecology and Environment: Organism and the environment; Population, community, ecosystem and biosphere; Major biomes; Ecological succession; Productivity; Energy flow in ecosystem; Nutrient cycling; Natural resources and its conservation; Biodiversity; Environmental pollution; Global environmental changes; Environmental ethics and legislation.

Morphology of plants and animals: Morphology and modification of root, stem and leaf; Inflorescence, flower, fruit, seed structure and types; Description of family poaceae, liliaceae, fabaceae, solanaceae and asteraceae; Meristematic and permanent tissues; Anatomy of root, stem and leaf; Secondary growth; Animal tissues-structure and function of epithelial, connective, muscular and nervous tissues; Salient features of earthworm, cockroach and rat.

Application of biology: Human population growth and factors; Common problem of drug, Alcohol and tobacco; Mental and addictive disorder; Common human diseases; Technology for medical application; Plant tissue culture and its application; Bioenergy; Biopesticide; Biopiracy; Bioethics; Domestication and improvement of plants and animals; Biomedical technologies such as radiography, angiography, sonography, ECG,EEG,ELISA test; Types, detection and diagnosis of cancer.

24. SYLLABI : NEE-II (Vocational)

(For Class –XII vocational / ITI / NERIST Certificate holder applicants seeking admission to Diploma module in Technology stream).

Full Marks : 150

Time: 3 Hours.

SECTIONS :

Section-A	Physics	25 marks.
Section-B	Chemistry	25 marks.
Section-C	Mathematics	30 marks.
Section-D	Vocational Subject	70 marks.

Section-A PHYSICS

25 Marks

Units and dimensions: Units for measurements, systems of units, fundamental and derived units, SI units. Dimensional analysis and their applications. Motion in one and two dimensions : Objects in motion in one dimension, motion in a straight line, uniform motion, its graphical representation and formulae, speed and velocity, instantaneous velocity, uniformly accelerated motion, its position-time graph, velocity-time graph and formulae. Vectors and scalars, representations of vectors in two dimensions, unit vector, vector addition and multiplication, Resolution of vectors in plane, rectangular components, Scalar and vector products, Motion in two dimensions, projectile motion, uniform circular motion.

Laws of motion: Force and inertia, first law of motion, Momentum, second law of motion, impulse, Third law of motion, examples of third law, linear momentum, conservation of linear momentum, Equilibrium of concurrent forces, Static and kinetic friction, laws of friction, rolling friction, lubrication.

Work, Energy and Power: Work done by a constant force, Kinetic and potential energy, power, Work-energy principle, Spring constant, Gravitational potential energy, Conservation of energy, Elastic collision in one dimension.

Rotational motion: Centre of mass of a two-particle system, centre of mass of a rigid body, general motion of a rigid body, motion of centre of mass, nature of rotational motion, rotational motion of a single particle in two dimensions, Uniform circular motion and their examples, Torque, angular momentum, conservation of angular momentum, Moment of inertia and its physical significance.

Gravitation: Newton's law of gravitation, universal gravitational constant 'G', acceleration due to gravity 'g', mass and density of the earth, inertial and gravitational mass, variations of 'g'. Gravitational potential energy near the earth's surface, gravitational potential, orbital velocity, escape velocity, geostationary satellite.

Properties of matter: Inter atomic and intermolecular forces, states of matter, Elastic properties of solids, Hooke's law, Young's modulus, bulk modulus and modulus of rigidity. Fluid pressure, Pascal's law, buoyancy, flotation, Archimedes' principle, Atmospheric pressure. Surface Energy and Surface Tension, angle of contact, Capillary rise, Viscosity, Stokes law, streamline & Turbulent flow, Reynold's number, Bernoulli's Theorem & its applications.

Heat and thermodynamics: Kinetic theory of gases, pressure exerted by a Gas, kinetic Energy & Temperature, Measurement of temperature, Absolute temperature scale, Gas Laws and Avogadro's number. Specific heat of solids & liquids, Latent heats of fusion & vapourisation, Transfer of heat.

Oscillations and waves: Periodic motion, simple harmonic motion, equation of simple harmonic motion, kinetic and potential energy in simple harmonic motion, Oscillations due to a spring mass system, simple pendulum, time period of a simple pendulum. Wave motion, speed of a wave, principle of superposition, reflection of wave, Standing waves in string (graphical representation only), Sound wave and its propagation in different media, Effect of pressure and temperature on velocity of sound waves, characteristics of sound waves.

Electrostatics: Frictional Electricity, charges and their conservation, Coulomb's law, Electric field and potential due to a point charge, Dipole, its fields along the axis, Concept of dielectric and dielectric constant, Conductors and insulators.

Presence of free charges and bound charges inside a conductor, Capacitance, parallel plate capacitor with air and dielectric medium between the plates, series and parallel combination of capacitors, energy stored in a capacitor, van de graaff generator.

Current electricity: Electric current, Ohm's law, resistivity, resistance of different materials, temperature dependence of resistance, resistances in series and parallel, Kirchhoff's law - illustrations by simple examples, Wheatstone bridge and its applications for comparing emf of two cells and determination of internal resistance of a cell, Electric power and heating effects of current .

Magnetic effect of current : Oersted's experiment, Force on a moving charge in a uniform magnetic field, Force on a current carrying conductor and torque on current loop in a magnetic field, forces between two parallel current carrying conductors, definition of Ampere, Moving coil galvanometer and its conversion into ammeter and voltmeter.

Magnetism : Natural and man made magnets, properties of bar magnet, current loop as magnetic dipole, Lines of force in a magnetic field, Comparison of bar magnet and solenoid, Earth's magnetic field, Tangent galvanometer, vibration magnetometer, Electromagnets and permanent magnets.

Electromagnetic induction and alternating current: Induced emf, Faraday's laws, Lenz's law, electromagnetic induction, self and mutual inductance,

Ray Optics and Optical Instruments : Sources of light, luminous intensity, luminous flux, Reflection of light at plane and spherical surfaces, Curved mirrors, mirror formula. Refraction of light, refractive index, total internal reflection, spherical lenses, thin lens formulae, lens maker's formula, magnification. Refraction and dispersion of light due to prism, spectrometer - its use for the determination of refractive index of material of a prism, Scattering of light in atmosphere, primary rainbow, Optical instruments - simple and compound microscopes, refracting and reflecting telescopes.

Section-B CHEMISTRY

25 Marks

Structure of Atom: Discovery and properties of sub-atomic particles (electron, proton and neutron), Rutherford's atomic model, Bohr's model of hydrogen and hydrogen-like atoms, Spectrum of hydrogen, Heisenberg's uncertainty principle, Dual nature of electron, de-Broglie equation, Quantum numbers, Concept of atomic orbital, Pauli's exclusion principle, Hund's rule of maximum multiplicity, Aufbau principle, Electronic configuration of elements up to atomic number 20.

Chemical Bonding: Ionic, Covalent, Co-ordinate covalent, Hydrogen and metallic bonds, Properties of compounds having these bonds. Hybridization and VSEPR theory for the molecular shape of simple molecules such as BeCl_2 , BF_3 , CH_4 , CCl_4 , NH_3 , H_2O , NH_4^+ , H_3O^+ , PCl_5 , SF_6 , C_2H_4 and C_2H_2 .

Periodic Properties of Elements: Mendeleev's periodic table and long form of the periodic table (Main features, merits and demerits), Periodic properties (Metallic characters, ionization potential electron affinity and electronegativity), Classification of elements into s, p, d and f - blocks, General trends of periodic properties of s- and p-block elements.

Gaseous State: Physical properties of gases, Laws governing their behavior (Boyle's Law, Charles's Law, Gay-Lussac's Law, Avogadro's law, Dalton's law of partial pressure, Graham's law of diffusion), Ideal gas equation, Kinetic molecular theory of ideal gases, Deviation from ideal behaviour, van der Waals equation of state; Continuity of states, Importance of critical constants, Liquefaction of gases.

Chemical Equilibrium: Reversible reaction, Law of mass action and its application to chemical equilibrium, Homogeneous and heterogeneous equilibrium, Le Chatelier's principle and its application, Ionic equilibria. Theory of electrolytic dissociation, Ostwald's dilution law; Arrhenius, Bronsted - Lowry and Lewis concepts of acids and bases.

Redox Reactions: Oxidation and reduction processes (classical and modern concepts), Oxidation state, Calculation of equivalent mass of oxidizing and reducing agents, Balancing of redox reactions using oxidation number and ion-electron methods.

Electrochemistry: Faraday's laws of electrolysis (statement, explanation and application), Numerical problems; Electrical conductance, specific conductance, equivalent and molar conductances; General concept of Galvanic cell and its representation; Electrode potential, Standard hydrogen electrode and reference electrode, Electro-chemical series and its applications, EMF of a Galvanic cell, Nernst equation for electrode and cell potentials; Some commercial cells and batteries.

Organic chemistry: Classification of organic compounds, Nomenclature of hydrocarbons and compound containing one functional group, homologous series, Isomerism. General methods of preparation and properties of Alkanes, Alkenes and Alkynes. Aromatic hydrocarbons, Structure of benzene. Electrophilic substitution reactions in benzene.

Organic compounds with one functional group: Simple methods of preparation and properties of Halo-alkanes, Alcohols, Phenols, Ethers, Aldehydes, Ketones, Carboxylic acids, Derivatives of carboxylic acid, amino-, cyano-, isocyano-, azo-, and nitro- compounds.

Section-C MATHEMATICS

30 Marks

Trigonometry: Trigonometric ratios of compound, multiple and sub-multiple angles, General solution of trigonometric equations, Properties and solution of triangles, Inverse circular functions.

Algebra: (i) Complex Numbers : Complex number and its properties, Different forms of complex numbers, roots of complex numbers, cube roots of unity and their properties, De-Moivre's theorem.

(ii) Progressions : Arithmetic and Geometric progressions, Arithmetic and Geometric means, Harmonic Progression, sum of n-terms and nth terms of A.P. & G.P.

(iii) Permutation and combinations, Binomial theorem for positive integral index, Middle term, greatest term, Binomial coefficients.

(iv) Partial fractions of different forms

(v) Determinants of order two, three and their properties.

Coordinate Geometry(2D): Coordinates of a point in a plane, distance between two points, Division of a line segment in a given ratio (internal and external division), Different forms of equation of a straight line, Distance of a point from a line, Angle between two lines, Bisector of an angle between two lines, Pair of straight lines, Equation of a circle, tangent and normal to a circle, Equation of second degree representing a conic section, Basic ideas about parabola, ellipse and hyperbola.

Coordinate Geometry (3D): Coordinates of a point in three dimensions, Distance between two points, division of join of two points. Angle between two lines, Direction cosines and direction ratios of a line, Projection of a point on a line.

Equation of a plane, Different forms of equation to a plane, Angle between two planes, Plane through three given points, Angle between a plane and line, Equation of a straight line in space, Coplanar lines, shortest distance, centre and radius of sphere.

Vector Algebra: Vector and its components, Different kinds of vectors, Addition and subtraction of vectors, scalar and vector products of two and three vectors.

Differential Calculus: Functions and their representation limit, continuity and differentiability of a function, Derivatives of elementary functions Derivatives of sum, product and quotient of functions, Derivatives of exponential, logarithmic and hyperbolic functions. Successive differentiation and Leibnitz theorem, Rolle's theorem and Lagrange's mean value theorem, L'Hospital's Rule, Curvature, Asymptotes, and concepts of curve tracing, Maxima & minima of functions of one variable.

Integral Calculus: Integration, Integral of elementary functions, Integration by parts and by substitution, Integral of rational functions and trigonometric functions, Integration of irrational functions Definite Integrals, Area under simple curves.

Statistics: Mean, median, mode and standard deviation of discrete and grouped data.

Section-D VOCATIONAL SUBJECT

70 Marks

Note: Each Vocational Subject (from Sl. No. 1 to 8 below) consists of the Syllabus of Common Engineering Sciences (a) and that of one Trade/Branch subject (b) appropriate to the academic qualification of an applicant.

(1) AE(FE) - Agricultural Engineering (Farm Equipment Trade)

(a) Common Engineering Sciences:

(10 questions of 1-mark each & 5 questions of 2-marks each).

Engineering Drawing : Lines, lettering and dimensioning, geometrical construction, scales, Engineering curves, conic sections, cycloid, Projection of points, straight lines, planes and solids, Sectional views, Isometric views, Auxiliary Projections.

Workshop : Hand tools for carpentry and fitting, forging, welding, specification and use; various operations : sawing, planing, chiseling, joining, filing, marking, chipping, gas cutting, maintenance and types of maintenance (preventive and corrective), materials for machine components.

Mechanics : Vector concept, force and force system, static equilibrium, Newton's laws of motions and derived concepts like friction, centroid, area, moment of inertia, work energy principle and application of impulse.

Electricity : Concept of voltage, current, resistance, power and energy, relation between electrical, mechanical and thermal units, temperature coefficient of resistance. Ohm's law, series, parallel, circuits and Kirchoff's law, Capacitance and inductance.

(b) Farm Equipment Trade:

(20 questions of 1-mark each & 15 questions of 2-marks each).

Tractors and power tillers : History of tractor and power tillers, technical specifications of various types and models of tractors and power tillers. Working principles of tractor and power tiller engines including fuel system, cooling system, lubrication, air intake and exhaust system. Working principles of clutch, gear box, final drive, steering, brake, hydraulic and electrical system. P.T.O. and belt pulley. Wheels and ballasting.

Farm machinery : Agricultural mechanization, scope, benefits and limitations. Land reclamation machinery. Equipment required for seedbed preparation, sowing, planting, interculture, irrigation, plant protection, harvesting and threshing. Implement hitching, safety in operation, Machinery management. Servicing and maintenance : Selection of site for establishing centre for repair and overhaul of tractors. Selection of hand tools, workshop machines, materials, seals and packing. Repair and preventive maintenance of general purpose machine components like fasteners, bearing, coupling, spring and elements of rotary motion drive. Fault diagnosis of various systems of engine, tractor and power tiller, checking of wear and tear, repair of worn out components and maintenance. Routine and preventive maintenance of tractor, repair and maintenance of farm equipment and land reclamation machinery.

(2) AE(FP) - Agricultural Engineering (Food Processing Trade)

(a) Common Engineering Sciences:

(10 questions of 1-mark each & 5 questions of 2-marks each).

Engineering Drawing : Lines, lettering and dimensioning, geometrical construction, scales, Engineering curves, conic sections, cycloid, Projection of points, straight lines, planes and solids, Sectional views, Isometric views, Auxiliary Projections.

Workshop : Hand tools for carpentry and fitting, forging, welding, specification and use; various operations : sawing, planing, chiseling, joining, filing, marking, chipping, gas cutting, maintenance and types of maintenance (preventive and corrective), materials for machine components.

Mechanics : Vector concept, force and force system, static equilibrium, Newton's laws of motions and derived concepts like friction, centroid, area, moment of inertia, work energy principle and application of impulse.

Electricity : Concept of voltage, current, resistance, power and energy, relation between electrical, mechanical and thermal units, temperature coefficient of resistance. Ohm's law, series, parallel, circuits and Kirchoff's law, Capacitance and inductance.

(b) Food Processing Trade:

(20 questions of 1-mark each & 15 questions of 2-marks each).

Food material characteristics and properties. Chemistry and microbiology of food, its processing and preservation. Food additives, Browning reaction. Adulteration and food laws. Nutritive value of foods. Unit operation in food processing like washing, cleaning, sorting, grading, sizing, screening, heating, cooling, blanching, smoking and material handling etc. and related equipments. Food preservation principles and methods. Food processes such as drying, dehydration, heat treatment, refrigeration, freezing, fermentation, irradiation, evaporation and concentration etc. Food packaging materials and methods. Processing and preservation methods of fruits and vegetables, milk, fish, meat and egg etc. and manufacture of their different products. Instrumentation in food industry, Instruments for measurement of process parameters, Steam generation, refrigeration and plant utilities in a food processing plant, Equipment servicing, repair and maintenance of common post harvest (including pulse and cereal milling), food and milk processing operations. Food grade engineering materials. Cleaning, hygiene, sanitation and sterilization of food processing and handling equipment.

(3) CE(CT) - Civil Engineering (Construction Technology or Draftsman/Surveyor Trade):

(a) Common Engineering Sciences:

(10 questions of 1-mark each & 5 questions of 2-marks each).

Engineering Drawing : Lines, lettering and dimensioning, geometrical construction, scales, Engineering curves, conic sections, cycloid, Projection of points, straight lines, planes and solids, Sectional views, Isometric views, Auxiliary Projections.

Workshop : Hand tools for carpentry and fitting, forging, welding, specification and use; various operations : sawing, planning, chiseling, joining, filing, marking, chipping, gas cutting, maintenance and types of maintenance (preventive and corrective), materials for machine components.

Mechanics : Vector concept, force and force system, static equilibrium, Newton's laws of motions and derived concepts like friction, centroid, area, moment of inertia, work energy principle and application of impulse.

Electricity : Concept of voltage, current, resistance, power and energy, relation between electrical, mechanical and thermal units, temperature weft of resistance. Ohm's law, series, parallel, circuits and Kirchoff's law, Capacitance and inductance.

(b) Construction Technology or Draftsmanship / Surveyor Trade:

(20 questions of 1-mark each & 15 questions of 2-marks each).

Construction Material : Rocks, bricks, tiles, sand, cement, lime and cement mortar, concrete, timber, steel, paints and varnishes, distemper, plastics, glasses, asphalt, sound and heat insulating materials.

Construction and Maintenance: Building Construction: Types of Brick and Stone masonry; Types and components of foundations, floors, doors and windows, arches and lintels, walls, stairs and roofs; Roads: Geometric features of road WBM and BBM pavements, Equipments used in road construction; Railways: Components, Construction and maintenance of tracks, Points and Crossings; Hydraulic Structure: Types and construction of Dams and Canals.

Surveying: Various surveying instruments; Methods of chain surveying, compass surveying, plane table surveying, theodolite surveying, leveling and contouring.

Water Supply and Sanitation : Sources of water, pumps, types of distribution systems, appurtenances in distribution system, sanitary system, construction and maintenance of sewers. Different types of water supply and sanitary fittings, Septic tanks.

Civil Engineering Drawings: Signs and symbols used in Civil Engineering Drawings, Drawings related to : Different types of masonry bonds, Sub-structure details, Timber joints, Riveted, Bolted and Welded joints, and Steel and Timber trusses.

Estimation and Quantity Surveying : Types and methods of estimates; Estimation of earthwork, masonry, RCC works, flooring, plastering, white washing and painting, sanitary fittings; Specifications of construction materials and various items of works.

(4) ECE (ET or EM) - Electronics and Communication Engineering (Electronics Technology or Electronics Maintenance Trade):

(a) Common Engineering Sciences:

(10 questions of 1-mark each & 5 questions of 2-marks each).

Engineering Drawing : Lines, lettering and dimensioning, geometrical construction, scales, Engineering curves, conic sections, cycloid, Projection of points, straight lines, planes and solids, Sectional views, Isometric views, Auxiliary Projections.

Workshop : Hand tools for carpentry and fitting, forging, welding, specification and use; various operations : sawing, planing, chiseling, joining, filing, marking, chipping, gas cutting, maintenance and types of maintenance (preventive and corrective), materials for machine components.

Mechanics : Vector concept, force and force system, static equilibrium, Newton's laws of motions and derived concepts like friction, centroid, area, moment of inertia, work energy principle and application of impulse.

Electricity : Concept of voltage, current, resistance, power and energy, relation between electrical, mechanical and thermal units, temperature coefficient of resistance. Ohm's law, series, parallel, circuits and Kirchoff's law, Capacitance and inductance.

(b) Electronics Technology or Electronics Maintenance Trade:

(20 questions of 1-mark each & 15 questions of 2-marks each).

Circuits and Devices: Semiconductors, type of semiconductors, doping, p-n junction diodes and their characteristics, Bipolar transistor, transistor, biasing, CE, CB and CC configurations and their characteristics, principles of class A, AB, B & C amplifier, gain, bandwidth, introduction to feedback amplifiers, Sinusoidal oscillator, clipping and clamping circuits, Mono-stable and Astable multivibrators. **Fundamentals of Communication & Radio Engineering:** E.M. wave propagation - ground wave, space wave and sky wave, Antenna radiation, different types of Antenna, Analog communication, AM, FM, principles of multiplexing - FDM & TDM, Introduction to digital communication, Multi - channel telephony, Super heterodyne receiver, typical circuits of various stages of transistorized receivers, working principle, RF and IF alignment, AVC and AGC. **T.V. and Audio System:** Monochrome T.V., Interlace scanning, synchronization, blanking pulses, bandwidth requirement, VSB, Picture resolution, typical circuits of the Video amplifier and EHT stages, function of keyed AGC, AFC, various controls in a T.V. receiver, Acoustics, high fidelity and high quality sound, sound recording - Disc and Tape, pool recording systems, equalization, Microphones and speakers, P.A. system, Record player, concept of Hi-Fi stereo. **Instruments :** Resistors, capacitors and inductors, Printed circuit board. Ammeter and Voltmeter - different types and their working principle. Analog and digital multimeters, DC power supply, Cathode ray oscilloscope and signal/function generators.

(5) EE(ET or EM) – Electrical Engineering (Electrical Technology or Electrical Maintenance Trade):

(a) Common Engineering Sciences:

(10 questions of 1-mark each & 5 questions of 2-marks each).

Engineering Drawing : Lines, lettering and dimensioning, geometrical construction, scales, Engineering curves, conic sections, cycloid, Projection of points, straight lines, planes and solids, Sectional views, Isometric views, Auxiliary Projections.

Workshop : Hand tools for carpentry and fitting, forging, welding, specification and its use; various operations : sawing, planing, chiseling, joining, filing, marking, chipping, gas cutting, maintenance and types of maintenance (preventive and corrective), materials for machine components & tools

Mechanics : Vector concept, force and force system, static equilibrium, Newton's laws of motions and derived concepts like friction, centroid, area, moment of inertia, work energy principle and application of impulse.

Electricity : Concept of voltage, current, resistance, power and energy, relation between electrical, mechanical and thermal units, temperature coefficient of resistance. Ohm's law, series, parallel, circuits and Kirchoff's law, Capacitance and inductance.

(b) Electrical Technology or Electrical Maintenance Trade:

(20 questions of 1-mark each & 15 questions of 2-marks each).

Basic Electricity: Primary, Secondary cell and charging of lead acid batteries, Capacitance and inductance their series, and parallel connection and energy storage, A.C. fundamental, wave shape, cycle, frequency, time period, peak, average and r.m.s. value, form factor, phase difference, peak factor, power factor, Series A.C. RLC circuit.

Electrical Machine: Magnetic effect of current, Faraday's law of electro-magnetic induction, force acting on a current carrying conductor in a magnetic field and torque production, D.C. machine-working principle of D.C. motor and D.C. generator, D.C. motor starting and speed control, common faults, causes, testing and applications, Single phase transformer - working principle. Turns ratio, voltage, current, power relation and applications, Single phase A.C. motor - commonly used single phase A.C. motors, starting, speed control, installation, testing, common faults and their causes and testing, Universal motor.

Instruments: Permanent magnet moving coil and moving iron, voltmeter and ammeter, Dynamometer type wattmeter, ohm meter, megger, induction type energy meter, their connection and application for measurement.

Electrical Appliances: Construction, principles, connection, common faults their causes and testing of the following equipments, Electric room heater, electric iron, electric stove, geyser, electric kettle, electric fans, (ceiling and table fan).

House Wiring : Cleat wiring, casing and capping wiring, batton wiring, conduit wiring and PVC wiring, controlling of lamps from two or three places. Schematic diagram of service connection.

Testing and connection of domestic wiring installation, Wiring faults and rectification, Installation of plate and pipe earthing, Procedure for measurement of earth resistance.

Electrical Drawing: Symbols used for common electrical equipments/appliances, Simple schematic and wiring – diagrams.

(6) ME(MC) - Mechanical Engineering (Mechanical Craftsmanship Trade):

(a) Common Engineering Sciences:

(10 questions of 1-mark each & 5 questions of 2-marks each).

Engineering Drawing : Lines, lettering and dimensioning, geometrical construction, scales, Engineering curves, conic sections, cycloid, Projection of points, straight lines, planes and solids, Sectional views, Isometric views, Auxiliary Projections.

Workshop : Hand tools for carpentry and fitting, forging, welding, specification and its use; various operations : sawing, planing, chiseling, joining, filing, marking, chipping, gas cutting, maintenance and types of maintenance (preventive and corrective), materials for machine components & tools.

Mechanics : Vector concept, force and force system, static equilibrium, Newton's laws of motions and derived concepts like friction, centroid, area, moment of inertia, work energy principle and application of impulse.

Electricity : Concept of voltage, current, resistance, power and energy, relation between electrical, mechanical and thermal units, temperature weft of resistance. Ohm's law, series, parallel, circuits and Kirchoff's law, Capacitance and inductance

(b) Mechanical Craftmanship Trade:

(20 questions of 1-mark each & 15 questions of 2-marks each).

Sheet metal operations, Tools and their specifications, carpentry (selection and wood working), pattern making; Various fitting tools and their specifications; Limits, fits and tolerances; Engineering and geometrical drawing; projections; isometric drawing; Reading engineering drawings;

Basic manufacturing processes like casting, forming welding and metal cutting, various casting processes, sand casting, die casting, centrifugal casting. Casting defects, melting furnaces.

Forging hammers and presses and various forging operations like upsetting, drawing, punching, etc. stock calculations.

Various welding processes and equipments, Arc welding, gas welding, electrode specification and IS codes, Arc characteristics, TIG, MIG welding, soldering and brazing.

Various machine tools like lathe, milling, shaping, drilling machines, simple calculations, Various operations like turning, facing, threading, knurling, groove cutting etc., Taper, thread cutting calculations, gear cutting on milling machine; different Grinding methods;

Materials for machine tool components and cutting tools, cutting fluid, lubricants.

Measuring Tools (i.e. vernier, micrometer, gauges, comparators etc.).

(7) ME(AT) - Mechanical Engineering (Automobile Technology Trade):

(a) Common Engineering Sciences:

(10 questions of 1-mark each & 5 questions of 2-marks each).

Engineering Drawing : Lines, lettering and dimensioning, geometrical construction, scales, Engineering curves, conic sections, cycloid, Projection of points, straight lines, planes and solids, Sectional views, Isometric views, Auxiliary Projections.

Workshop : Hand tools for carpentry and fitting, forging, welding, specification and its use; various operations : sawing, planing, chiseling, joining, filing, marking, chipping, gas cutting, maintenance and types of maintenance (preventive and corrective), materials for machine components.

Mechanics : Vector concept, force and force system, static equilibrium, Newton's laws of motions and derived concepts like friction, centroid, area, moment of inertia, work energy principle and application of impulse.

Electricity : Concept of voltage, current, resistance, power and energy, relation between electrical, mechanical and thermal units, temperature weft of resistance. Ohm's law, series, parallel, circuits and Kirchoff's law, Capacitance and inductance.

(b) Automobile Technology Trade:

(20 questions of 1-mark each & 15 questions of 2-marks each).

Different types of automobiles, types of IC engine and their components, auto cycle and diesel cycle, IHP, BHP and FHP and their calculations, cooling system, lubrication system, differential, transmission system, braking system, and lighting system, Two stroke/four stroke engines, valve timing diagrams, carburetor and injector repairing of trouble shooting and remedial measures, servicing of a vehicle, repairs, functions of gear box of scooter, car or truck, working of dynamo, fuel pumps, function of clutches, motor cycles or scooters, steering mechanism, wheels and tyres and their repairs.

(8) ME(RAC)- Mechanical Engineering (Refrigeration & Air Conditioning Trade):

(a) Common Engineering Sciences:

(10 questions of 1-mark each & 5 questions of 2-marks each).

Engineering Drawing : Lines, lettering and dimensioning, geometrical construction, scales, Engineering curves, conic sections, cycloid, Projection of points, straight lines, planes and solids, Sectional views, Isometric views, Auxiliary Projections.

Workshop : Hand tools for carpentry and fitting, forging, welding, specification and its use; various operations : sawing, planing, chiseling, joining, filing, marking, chipping, gas cutting, maintenance and types of maintenance (preventive and corrective), materials for machine components.

Mechanics : Vector concept, force and force system, static equilibrium, Newton's laws of motions and derived concepts like friction, centroid, area, moment of inertia, work energy principle and application of impulse.

Electricity : Concept of voltage, current, resistance, power and energy, relation between electrical, mechanical and thermal units, temperature coefficient of resistance. Ohm's law, series, parallel, circuits and Kirchoff's law, Capacitance and inductance.

(b) Refrigeration & Air Conditioning Trade:

(20 questions of 1-mark each & 15 questions of 2-marks each).

Refrigeration systems, Air cycle refrigeration, vapor compression cycle, deviation of actual cycle from the theoretical cycle, study of charts and tables for refrigerants. Refrigeration of refrigeration processes on temperature - entropy and pressure - enthalpy diagrams. Absorption - compressor, evaporator, pumps, valves. Components of air conditioning, humidification and dehumidification, drying, evaporative cooling, comfort charts, year round air conditioning, air conditioning of cold storage, auditorium, aircrafts, locomotives. Sensible and latent heat, heat load calculation, Psychrometry, use of psychrometric chart, air distribution and Ventilation systems, Types of fans and their ratings and mountings.