SYLLABUS OF SLIET ENTRANCE TEST (SET-VI)
For admission to M.Sc. Programme-2022
Pattern of SET-VI

SLIET Entrance Test (SET-VI) for admission to M.Sc. programme will consist of one paper of one hour and forty minutes duration. This paper will have 100 objective type questions of 100 marks.

Note-: Answers of the objective type questions are to be filled in the OMR answer sheet given separately during the examination. There will be 25% negative marking for wrong answers.

Syllabus for M.Sc.

Marks: 100 (100 Questions) **Time: 1 Hour 40 Minutes**

Common for all M.Sc

Marks: 15 (15 Questions – Minimum 05 from each topic)

a) Arithmetic and Quantitative Skills

b) Critical Reasoning & General Awareness

M.Sc. (Physics)

Marks: 85 (85 Questions)

1. Basic Concepts of Classical Mechanics: Mechanics of a particle, Mechanics of a system of particles, constraints, Holonomic and non-holonomic constrants, virtual work, D'Alembert's principle, Lagrange's equations, simple applications of the Lagrangian formulation.

2. De Broglie waves and uncertainty principle: De Broglie Waves, Wave function, De Broglie wave velocity, wave and group velocities, Heisenberg's uncertainty principle and its applications.

3. Schrodinger equation: The wave function, schrodinger equation – time dependent form Expectation values, operators, Schrödinger equation–steady state form, Eigen values and eigen functions.

4. Application of Schrödinger equation: The particle in a box – energy quantization, wave functions, momentum quantization. The Harmonic oscillator – Energy levels, wave functions, Hydrogen atom, Schrodinger equation for the hydrogen atom, separation of variables, quantum numbers –Total quantum number, orbital quantum number, magnetic quantum number, The normal Zeeman effect.

5. Atomic Spectra: Spectra of hydrogen, alkali atoms, spectral terms, doublet fine structure, screening constants of alkali spectra for s, p, d, f states, selection rules singlet, triplet fine structure in alkaline earth spectra, L-S and J-J coupling.

6. Molecular Spectra: Molecular spectra – experimental study, Rotational Spectra, Intensities of rotational lines, vibrational spectra, rotational and vibrational bands and their theoretical explanation. Raman spectra – Raman effects, Introduction, Experimental Study, Results of Raman effect, Nature of Raman effect, Theoretical explanation of Raman effect, Practical importance of Raman effect, Raman effect and molecular constitution.

7. Nuclear Physics: Nuclear models and accelerators – Introduction to nuclear forces, Nuclear binding energy, shell model and liquid drop model, Nuclear reactions, Fission and Fusion, Particle accelerators – linear accelerator and cyclotron. Elementary Particles – Introduction to elementary particles and their conservative principles, Theory of electron, Antiparticles, mesons, mesons and mesons, Symmetries of elementary particles, conservative principles.

8. Crystal Structure: Crystal lattice and translation vectors, unit cell, Basis, symmetry operations, Point groups and space groups, Types of lattices (Plane lattice and space lattice with bcc and fcc) Lattice directions and planes, Interplanar spacings Miller indices, simple crystal structures, close packed structures, Hexagonal close packed structures.

9. Bonding in Solids: Introduction, concept of inter-atomic forces, cohesive energy and types of bonding, primary bonds (ionic bonds, covalent bond and metallic bonds), Secondary bonds (Vander wall's bonds and hydrogen bonds)

10. Heat Capacity: Classical theory of lattice heat capacity (concept and comparison with experimental value), concepts of Einstein's theory of lattice heat capacity, Density of modes of vibrations (in 1-D, 2-D and 3-D), Debye's model of lattice heat capacity (derivation), Limitations of Debye's model.

11. Electrical properties of metals: Classical free electron theory of metals, Drawbacks of classical theory, Quantum theory of free electron, sommerfield's model for free electron (one-dimensional solid, generalization for three-dimensional solid) Fermi-Dirac statistics and electron distribution in solids, Density of energy states and Fermi energy f(E) at $E=E_F$, $E<E_F$ and $E>E_F$, Fermi-Dirac distribution function, Mean energy of electron gas at absolute zero.

12. Band Theory of Solids: The Bloch theorem (only statement and properties), The kronig –Penny model, Energy versus wave-vector relationship – different representations (Brillouin Zones), Distinction between metals, insulators and semiconductors.

13. Magnetic Properties of Solids: Concept of Magnetic permeability, magnetization, susceptibility, Electric current in atoms, Bohr Magnetron, Electron Spin and Magnetic Moment, Magnetic moment due to nuclear spin, classical theory of diamagnetism and paramagnetism, Quantum theory of paramagnetism, Domain theory of ferromagnetism, Experimental demonstration of domain structure, I-H curve.

14. Bipolar Junction Transistor – BJT : BJT (Revision), Load line, Transistor biasing, voltage divider bias, Hybrid parameters (or h parameters) Determination of h-parameters, common – emitter amplifier, Analysis of common emitter amplifier and common – collector amplifier using h-parameters current gain, voltage gain, power gain, input resistance and output resistance)

15. Digital Electronics: Binary and Hexadecimal number system, Binary Arithmetic, Basic logic gates (NOT, OR, AND using electrical switch circuit only), Derived logic gates (NAND, NOR, EXOR using electrical switch circuit only) De Morgan's theorem, NAND gate as a universal building block, half adder and full adder, RS flip flop and JK flip flop (using logic gates only)

16. Second law of Thermodynamics: Conversion of work in to heat and vice versa, Kelvin-Planck and Clausius statements of Second law of Thermodynamics and their equivalence, Carnot.s cycle, Carnot.s theorem and coreollary, thermodyanamic scale of temperature, absolute zero and efficiency, gasoline engine(Otto),Diesel engine, reversibility and irreversibility, condition for reversibility.

17. Entropy: Reversible part of the second law, Entropy, principle of carateodory, entropy of an ideal gas -- T- S diagram of entropy and reversibility, entropy and irreversibility, irreversible part of second law, heat and entropy of irreversible processes, entropy and nonequilibrium states,principle of increase of entropy, applications of entropy principle, entropy and disorder, enthalpy, Helmholtz and Gibb.s functions, maxwell.s relations, T DS equations, internal energy equation, heat capacity equation.

18. Interference by Division of Amplitude: Interference in thin films, the cosine law, nonreflecting films, high reflectivity by thin film deposition, interference by wedge shaped film. Newton.s rings.the Michelson interferometer

19. Fraunhoffer and Fresnel Diffraction: Single slit, double slit, N slit diffraction patterns. Positions of maxima and minima.width of the principal maxima.the diffraction grating. Resolving power of grating. Resolving power of a prism, Fresnel half period zones.zone plate.diffraction at a straight edge.Fresnel diffraction by a circular aperture.

20. Polarization and double refraction: Introduction-production of polarized light, polarization by reflection, polarization by double refraction, polarization by scattering, Malus law, Superposition of two disturbances, Mathematical analysis, Double refraction, Normal incidence, oblique incidence, interference of polarized light, QWP, HWP, Analysis of Polarised light, Optical activity.

M.Sc. (Chemistry)

Marks: 85(85Questions)

Inorganic Chemistry

Atomic Structure and Chemical bonding: Schrodinger wave equation; H atom; Radial and angular wave functions: quantum numbers and concept of orbitals; Slater orbitals; Periodic trends and properties: Size, Ionization Energy, Electron Affinity, Electronegativity, Lattice and Hydration Energies; Chemical Bonding: VB and MO approach of H_2 molecule; MO treatment of homonuclear and heteronuclear (CO & NO) diatomic molecules; VSEPR theory; Structure of simple molecules and ions of main

group elements; theories of bonding in metals; Free electron, VB and Band theories; Hydrogen bonding and Vander Waal's interactions.

Chemistry of elements: *s* and *p*-block: Alkali and alkaline earth metals, Hydrides and Complexation tendencies, Structural features of hydrides, halides, oxides and oxyacids;

d-block: Salient features, characteristic properties of 3*d*-elements and general comparative treatment of 4d and 5d elements with reference to oxidation states, colour, magnetic behaviour, and complex formation tendency, methods of determining magnetic susceptibility, Correlation of magnetic moment data and stereochemistry of Co(II) and Ni(II) complexes. *f-block*: Comparative study of lanthanides and actinide elements with respect to electronic configuration, atomic and ionic radii, oxidation states and complex formation, occurrence and principles of separation.

Coordination chemistry: Nomenclature, Werner's theory, Iso*merism*. Sidgwick's EAN concept and Valence Bond Theory, Limitations of valence bond theory; Crystal-field theory and crystal-field splitting in octahedral, tetrahedral and square planar complexes, Jahn-Teller distortion, Factors affecting the crystal-field splitting; Stereochemistry of coordination compounds with coordination no. 4, 5 and 6;

thermodynamic and kinetic stabilities of metal complexes and factors affecting the stability; Types of electronic transitions, selection rule for d-d transitions, spectroscopic ground states.

Organometallic Chemistry: Definition, nomenclature and classification of organometallic Compounds; Preparation, properties, bonding and applications

Bioinorganic Chemistry: Essential and trace element in biological process, oxygen transport with reference to haemoglobin; synthetic models of O_2 carriers, Biological role of alkali metals ions; Vitamin B-12

Organic Chemistry

Concepts: Atomic orbitals, hybridization, Polarity of bonds: Inductive, resonance and steric effects, hyperconjugation, and their influence on acidity and basicity of organic compounds; Fischer, Saw-horse and Newman projection formulae,

Chirality-optical activity, enantiomersim and diasteroisomerism involving one and two chiral centres; Configuration; D/L, erythrose, threose and R/S nomenclatures; Geometrical isomerism and E/Z nomenclatures; Conformations of n-butane; Aromaticity and Huckel rule - A general concept; Molecular orbital picture of benzene, Nomenclature of organic compounds

Chemistry of organic compounds- Hydrocarbons: Alkanes, Alkenes, alkaenes and benzene: Preparation and properties; Alkyl Halides: Nucleophilic substitution: SN1, SN2 mechanisms; Eliminations reactions: E1and E2 mechanisms, Elimination versus substitution reactions; energy profile diagrams-transition states (general considerations). Grignard reagents:

Preparation and synthetic applications; Chlorobenzene, electrophilic and nucleophilic aromatic substitutions; side chain chlorination of toluene, DDT and BHC; Alcohols: Comparative study of substitution, dehydration, oxidation, and esterification of primary, secondary and tertiary alcohols; Phenols: General methods of preparation and reactions; Reimer-Tiemann and Kolbe reactions; Relative acidity of phenol, alcohol and carboxylic acid; Carbonyl compounds: Preparations and reactions: addition and condensation reactions; Cannizzaro, Perkin, aldol, benzoin, haloform, oxidation and reduction reactions; Important reactions of acids, HVZ reaction, Relative reactivity of acid chlorides, acid anhydrides, amides and esters; Comparative acidity of carboxylic and sulphonic acids; Nitrogen containing compounds: Nitronbenzene and reduction products; Comparative basicity of aliphatic and aromatic amines; Diazonium Salts: Preparation and synthetic applications.

Reactive intermediates and related Rearrangement reactions: Generation, stability and reactivity of Free radicals (Anti Markovnikov's, Birch Reduction, Bouveault-Blanc reduction, oxidation of phenol by metal ions); *Carbocations* (Pinacol-Pinacolone, Wagner-Meerwein Rearrangement, Baeyer-Villiger oxidation, Hydroperoxide reaction and Beckmann.) and *Carbanions (*Robinson Anuulation and Michael Addition); *Carbenes* and *Nitrenes* (Hofmann, Curtius reactions); Ylides: Sulphur ylides, phosphorous ylides, Michaelis-Arbuzov phosphonate synthesis, Witting reactions, Mitsunobu reaction.

Chemistry of Bio-molecules: Amino acids-preparative methods, physical properties, dipolar nature, chemical reactions and configuration; peptide linkage, peptide synthesis and structure of poly peptides, General characteristics and secondary structure; Carbohydrates -Characteristic reactions of aldoses and ketoses; Glucose- structure (Open and Cyclic), Fructose (only reactions), Mutarotations, Sucrose, starch and cellulose (Structural aspects only).

Application of Spectroscopic Techniques: Infrared Spectroscopy: Working and experimental considerations in spectral recording; Characteristic group frequencies; carbonyl frequencies; effect of structure: aldehydes, ketones; esters, amides, acid anhydrides, carboxylics acids, acid chlorides; effect of conjugation; cyclization; ambi-dentate ligands and metal carbonyls.

Ultraviolet and Visible Spectroscopy: Basic working principle and measurement technique; σ-σ*, π-π*, n-σ* and n-π* transitions, dienes and conjugated poly-enes; Woodward-Fieser rules; spectra of transition metal complexes (*d-d* transitions).

NMR Spectroscopy: Working principle and method of measurement; factors influencing chemical shift, spin-spin splitting; applications.

Physical Chemistry

States of Matter: Gaseous state: Kinetic theory of gases, ideal gas laws based on kinetic theory, mean free path, collision diameter, collision number; van der Waal's equation and critical state,

Liquid State: Surface tension of liquids - capillary action, temperature effect on surface tension; Viscosity of liquids, experimental determination of viscosity coefficient, variation with temperature.

Solid State: Crystal lattices, space lattice, unit cell, crystal systems, law of rational indices, Miller indices, crystals and x-rays (the Braggs equation); Crystal structure of NaCl, graphite, and diamond; Types of crystal (molecular, covalent, metallic, ionic); Imperfection in crystals: point defect-Schottky and Frankel defects.

Thermodynamics: First Law of thermodynamics and internal energy, heat and work, Enthalpy, heat changes at constant volume and constant pressure, heat capacities (CV, CP). Thermodynamic quantities (w, q, ΔU, ΔH) for isothermal and adiabatic reversible expansion of ideal gases,

Relation between ΔU and ΔH, variation of heat of reaction with temperature (Kirchhoff's equation); Second Law of Thermodynamics, Carnot cycle, entropy, entropy changes in reversible and irreversible processes and of universe and changes of an ideal gas in different processes; Free energy and its concept, Gibbs and Helmholtz free energies and their relationship, variation of free energy with temperature and pressure; Free energy and equilibrium constant, Maxwell's relations, Gibbs-Helmholtz equations, Chemical potential, Fugacity and activity.

Thermodynamics of colligative properties: Ideal solutions and their characteristic properties, Duhem-Margules equation and its application, Henry and Raoult's laws, Freezing point depression, elevation of boiling point, osmotic pressure, van't Hoff equation, Measurement of osmotic pressure and determination of molecular weight of macromolecules.

***Electrochemistry*:** Arrhenius theory of electrolytic dissociation, Hydrolysis of salts, hydrolysis constant, Bronsted-Lowry and Lewis concepts of acids and bases, HSAB theory and applications buffer solutions, indicators and theory of acid-base indicators, degree of dissociation and dissociation constant of weak electrolytes/acids, solubility of sparingly soluble salts; Migration of ions: transference number and its determination by Hittorf methods; Conductance of electrolyte solutions, Kohlrausch law of independent migration of ions, ionic mobility; Single electrode potential (Nernst equation), Emf of reversible cell from electrode potentials and its applications; Types of reversible electrodes, reference electrodes; Concentration cells with and without transference; Liquid junction potential and its elimination, Qualitative idea of Debye-Huckel theory of ion-ion interactions.

***Phase Equilibria*:** Thermodynamics of phase transition-Clapeyron-Clausius equation and its applications, Phase rule, phase, component, degree of freedom, thermodynamic derivation of phase rule, phase diagrams of one-component system (water), two component systems (phenolwater,lead-silver). The distribution law, solvent extraction, equilibrium constant from distribution coefficient ($KI + I_2 = KI_3$).

Chemical Kinetics: Order and molecularity of chemical reactions, pseudo order, Kinetic law for second order reactions, determination of the rate constant and order of reaction from kinetic data, Effect of temperature on rate of reaction: collision theory of rates of bimolecular reactions and its comparison with Arrheninus equation.

Photochemistry: Law of photochemical equivalence, quantum efficiency, reasons for low and high quantum efficiency; Kinetics of photochemical reaction (H_2+Br_2=HBr), photostationary state, Chemical actinometers (uranyl oxalate).

Quantum Chemistry: Postulates of quantum mechanics, Schrödinger's wave equation, Eigen functions and Eigen values, Orthogonality of wave functions, Particle in a one dimensional box problem.

Molecular Spectroscopy: Region of electromagnetic spectrum, Emission and absorption spectra,Transition probabilities and selection rules; Width and intensity of spectral transitions Pure rotational spectra, Diatomic molecules-Rigid rotor & non-rigid

rotors. Vibrational- rotational spectra ofdiatomic molecules, Harmonic oscillator-rigid rotor approximation, Anharmonicity, Normal modes of vibration, Infrared spectra of linear and bent AB2 molecules; Electronic spectra of diatomic molecules, Franck-Condon principle; Nuclear Magnetic Resonance Spectroscopy: Principle, Chemical shifts, Spin-spin splitting, Relaxation times.

M.Sc. (Mathematics)

Marks: 85 (85 Questions)

Sequences and Series: Sequences of real numbers. Cauchy's criteria for convergence. Convergent sequences.
Series. Tests for convergence. Absolute and conditional convergence. Uniform convergence.

Differential Calculus: Limit. Continuity. Differentiability. Successive differentiation. Asymptotes. Curvature. Envelopes and evolutes. Mean value theorem. Taylor's theorem. Maxima and minima of functions of a single variable. Functions of two and three variables. Partial derivatives, maxima and minima. Tangent plane and normal to a surface. Errors and Approximations.

Integral Calculus: Integration. Reduction formulae. Quadrature and rectification. Double and triple integrals, Surface areas and volumes. Centre of gravity. Moment of inertia. Root mean square value. Beta, Gamma and error functions.

Vector Calculus: Scalar and vector triple products. Vector differentiation and integration. Gradient, divergence and curl. Green's, Stokes and Gauss theorems.

Three dimensional Geometry: Cartesian co-ordinate system, Distance formula, section formula, Direction ratios and direction cosines, Equation of a plane, Equations of straight line.

Differential Equations: Ordinary differential equations of the first order. Linear differential equations of higher order with constant coefficients. Methods of variation of parameters and undetermined coefficients. Series solution of differential equations. Bessel's and Legendre's equations. Orthogonality and recurrence relations of Bessel's functions and Legendre polynomials.
Partial differential equations. Lagrange's linear PDE. Non-linear PDE of first order. Charpit's method. Homogenous linear and non-linear PDEs. Application of ODE and PDE.

Algebra: Groups, subgroups and normal subgroups, Lagrange's Theorem for finite groups, group homomorphisms and basic concepts of quotient groups, rings, ideals, quotient rings and fields.

Linear Algebra: Systems of linear equations. Matrices, rank, determinant, inverse. Eigenvalues and eigenvectors. Cayley Hamilton theorem. Finite dimensional vector spaces over real and complex numbers. Basis. Dimension. Linear transformations.

Analysis: Riemann integral. Fundamental and mean value theorems of integral calculus. Improper integrals. Open and closed sets, limit points, completeness of R. Limit of a complex function. Differentiation. Analyticity. Cauchy-Riemann equations. Harmonic functions. Conformal mapping. Some special transformations - translation, inversion and rotation. Bilinear transformation.

Laplace Transform and Fourier series: Laplace transforms and its properties. Inverse Laplace transforms. Convolution theorem. Unit step function and unit impulse function. Applications to differential equations.
Fourier series. Change of interval. Even and odd functions. Half-range series. Applications to standard waveforms.

Solid Geometry: Sphere. Cone. Cylinder. Conicoid. Tangent plane and normal. Reduction of second degree equations to standard forms.

Mechanics: Coplaner forces. Virtual work. Catenary. Equilibrium. Wrenches. Simple harmonic motion. Elastic strings. Central orbits. Kepler's law of motion.

Statistics: Measures of central tendency and dispersion. Skewness and kurtosis. Correlation and regression. Probability theory. Baye's theorem. Binomial, Poisson and Normal distributions.