

## University Institute of Technology (UIT), H. P. University Shimla-05

### Pattern of B. Tech. (IT/CSE/ECE/CE/EE) Common Entrance Test

The entrance test for admission to B. Tech. courses in the UIT and the syllabus for entrance test shall be as per the following scheme:

1. There shall be only one paper consisting of 100 Multiple Choice Questions (MCQs) of duration 3 Hours. Therefore, the new pattern of UIT Entrance Test will be as follows:

Subject	No. of Questions	Time
(a) Physics	33 MCQ	<b>3 Hours</b>
(b) Chemistry	33 MCQ	
(c) Mathematics	34 MCQ	
<b>Total</b>	<b>100 MCQs</b>	

2. Each question will be of 2 marks.
3. There shall be negative marking of 0.5 marks for each wrong answer.
4. There shall be no score for un-attempted questions.
5. Displayed result shall show the marks scored by candidates in each subject and the total marks.
6. A combined merit list will be prepared for all the five courses (IT/ CSE/ ECE/ CE/ EE) on the basis of total marks scored by the candidates.
7. In case of a tie i.e. student obtaining equal marks (aggregate) in the entrance examination, the issue shall be resolved according to the higher marks obtained by the candidate in Mathematics part of entrance test followed by marks obtained in Physics part. Even if there is a tie in **inter-se** ranking after exhausting the above procedure, then the candidate younger in age will be given preference.
8. Seat will be allotted on the basis of above merit and the order of course preference opted by the candidate in the counselling form.

The syllabus and sample questions for different subjects shall be as follows:

## (a) Physics

**Mechanics** Unit and dimensions, displacement, velocity, acceleration, kinematics in one and two dimensions, projectiles, circular motion, concept of relative motion. Newton's laws of motion, concepts of inertial and uniformly accelerated frames. Force, spring force, frictional force, and gravitational force.

Work, energy and power, momentum, conservation of momentum and energy. Linear and angular momentum, simple, harmonic motion. Universal law of gravitation, gravitational potential and field, acceleration due to gravity, motion of planets and satellites in circular orbits, Kepler's laws.

**System of Particles:** Center of mass and its motion, elastic and inelastic collisions. Rigid bodies, moment of inertia, parallel and perpendicular axes theorems, moment of inertia of simple geometrical shapes, i.e. uniform ring, disc, thin rod, cylinder. Angular momentum, its conservation, torque, equilibrium of rigid bodies.

**Bulk Properties of Matter:** Hook's law; Young's shear and bulk modulus. Principle of buoyancy, pressure in fluid, streamlined flow, Bernoulli's theorem.

**Wave Motion:** concepts of amplitude, frequency and phase. Longitudinal and transverse waves, superposition of waves, progressive and stationary waves. Vibration of strings and air columns, resonance, beats, velocity of sound, Doppler effect.

**Heat and Thermodynamics:** Thermal expansion of solids, liquids and gases, ideal gas laws, absolute temperature, specific heats and their ratio, Isothermal and adiabatic processes. First law of thermodynamics, Carnot's cycle and refrigerator, Heat conduction in one dimension, elementary concepts of black body radiation. Stefan's law of radiation. Wien's displacement law.

**Electrostatics:** Coulomb's Law, electric field and electric potential, lines of force, capacitance, dielectric constant, parallel plate capacitor, capacitors in series and parallel. Energy stored in capacitor, charging and discharging of capacitor.

**Current Electricity:** Electric current, Ohm's law, series and parallel arrangements of resistance's and cells. Kirchoff's laws and applications to networks. Heating effect of current. Biot-Savart's law, force on a moving charge and on a current carrying wire in a magnetic field, magnetic moment of a current loop, effect of a uniform magnetic field on a current loop, moving coil galvanometer, voltmeter, ammeter.

**Electromagnetic Induction:** Faraday's law, Lenz's law, definitions of self and mutual inductance. A. C Generator, LCR circuit with A.C. Phasor diagrams and L-C

oscillations.

**Optics:** Reflection and refraction at plane and curved surfaces. Total internal reflection and critical angle. Deviation and dispersion of light by a prism. Thin lenses, Spherical aberration, microscope, telescope.

**Wave Nature of Light:** Interference. Young's double slit experiment, fringe width, elementary concepts of diffraction by a single slit.

**Atomic and Nuclear Physics:** Radioactivity: alpha, beta and gamma radiations, law of radioactive decay, decay constant, half-life and mean life Photoelectric effect, de-Broglie wavelength, Bohr's theory of hydrogen-like atoms. Atomic nucleus, binding energy and its calculation.

**Semiconductor Physics and Electronics:** Elementary concepts of metals. Insulators and semiconductors, Intrinsic and extrinsic semiconductors, p-n junction diode, rectifier, basics of transistors, transistor amplifier (in CE mode).

## (b) Chemistry

### 1. Physical Chemistry

**General Topics:** Concept of atoms and molecules; Dalton's atomic theory; Mole concept, Calculations (based on mole concept) involving common oxidation-reduction, neutralisation, and displacement reactions; Concentration in terms of mole fraction, molarity and normality.

**Gaseous And Liquid States:** Absolute scale of temperature, ideal gas equation; Deviation from ideality, van der Waals equation; Kinetic theory of gases, average, root mean square and most probable velocities and their relation with temperature; Law of partial pressures; Vapour pressure.

**Atomic Structure And Chemical Bonding:** Bohr model, spectrum of hydrogen atom, quantum numbers; Wave-particle duality, de Broglie hypothesis; Uncertainty principle; shapes of s, p and d orbitals; Electronic configurations of elements (up to atomic number 36); Aufbau principle; Pauli's exclusion principle and Hund's rule; Orbital overlap and covalent bond; Hybridisation involving s, p and d orbitals only; VSEPR model and shapes of molecules (linear, angular, triangular, square planar, pyramidal, square pyramidal, trigonal bipyramidal, tetrahedral and octahedral).

**Energetics:** First law of thermodynamics; Internal energy, work and heat, pressure-volume work; Enthalpy, Hess's law; Heat of reaction, fusion and vapourization; Second law of thermodynamics; Entropy; Free energy; Criterion of spontaneity.

**Chemical Equilibrium:** Law of mass action; Equilibrium constant, Le Chatelier's principle; Solubility product, common ion effect, pH and buffer solutions; Acids and bases (Bronsted and Lewis concepts).

**Electrochemistry:** Electrochemical cells and cell reactions; Standard electrode potentials; Nernst equation; Electrochemical series, emf of galvanic cells; Faraday's laws of electrolysis; Electrolytic conductance, specific, equivalent and molar conductivity.

**Solid State:** Classification of solids, crystalline state, seven crystal systems, close packed structure of solids (cubic), packing in fcc, bcc and hcp lattices; coordination number, packing fraction.

**Solutions:** Raoult's law; Molecular weight determination from lowering of vapour pressure, elevation of boiling point and depression of freezing point.

## 2. Inorganic Chemistry

### **Isolation/Preparation and Properties of the Following Elements and Compounds:**

Boron, silicon, nitrogen, phosphorus, oxygen, sulphur and halogens; Properties of allotropes of carbon (only diamond and graphite), phosphorus and sulphur.

Oxides, peroxides, hydroxides, carbonates, bicarbonates, chlorides and sulphates of sodium, potassium, magnesium and calcium; Boron: diborane, boric acid and borax; Aluminium: alumina, aluminium chloride and alums; Carbon: oxides and oxyacid (carbonic acid); Silicon: silicones, silicates and silicon carbide; Nitrogen: oxides, oxyacids and ammonia; Phosphorus: oxides, oxyacids (phosphorus acid, phosphoric acid) and phosphine; Oxygen: ozone and hydrogen peroxide; Sulphur: hydrogen sulphide, oxides, sulphurous acid, sulphuric acid and sodium thiosulphate; Halogens: hydrohalic acids, oxides and oxyacids of chlorine, bleaching powder; Xenon fluorides.

Oxides and chlorides of tin and lead; Oxides, chlorides and sulphates of  $\text{Fe}^{2+}$ ,  $\text{Cu}^{2+}$  and  $\text{Zn}^{2+}$ ; Potassium permanganate, potassium dichromate, silver oxide, silver nitrate, silver thiosulphate. Ores and minerals: Commonly occurring ores and minerals of iron, copper, tin, lead, magnesium, aluminium, zinc and silver.

**Transition elements (3d series) :** Definition, general characteristics, oxidation states and their stabilities, colour (excluding the details of electronic transitions) and calculation of spin-only magnetic moment; Coordination compounds: nomenclature of mononuclear coordination compounds, cis-trans and ionisation isomerisms, hybridization and geometries of mononuclear coordination compounds (linear, tetrahedral, square planar and octahedral).

## 3. Organic Chemistry

**Concepts:** Hybridisation of carbon; Sigma and pi-bonds; Shapes of simple organic molecules; Structural and geometrical isomerism; Optical isomerism; IUPAC nomenclature of simple organic compounds (only hydrocarbons, mono-functional and bi-functional compounds); Hydrogen bonds: definition and their effects on physical properties of alcohols and carboxylic acids; Inductive and resonance effects on acidity and basicity of organic acids and bases; Polarity and inductive effects in alkyl halides;

**Preparation, Properties and Reactions of Alkanes, Alkenes and Alkynes:** Homologous series, physical properties of alkanes (melting points, boiling points and density); Combustion and halogenation of alkanes; Preparation of alkanes by Wurtz reaction and decarboxylation reactions. Physical properties of alkenes and alkynes

(boiling points, density and dipole moments); Reactions of alkenes with  $\text{KMnO}_4$  and ozone; Reduction of alkenes and alkynes; Preparation of alkenes and alkynes by elimination reactions; Electrophilic addition reactions of alkenes with  $\text{X}_2$ ,  $\text{HX}$ ,  $\text{HOX}$  and  $\text{H}_2\text{O}$  ( $\text{X}$ =halogen); Addition reactions of alkynes; Metal acetylides.

**Reactions of benzene:** Structure and aromaticity; Electrophilic substitution reactions: halogenation, nitration, sulphonation, Friedel-Crafts alkylation and acylation.

**Phenols:** Acidity, electrophilic substitution reactions (halogenation, nitration and sulphonation); Reimer-Tiemann reaction.

**Alkyl halides:** Rearrangement reactions of alkyl carbocation, Grignard reactions, nucleophilic substitution reactions; Alcohols: esterification, dehydration and oxidation, reaction with sodium, phosphorus halides,  $\text{ZnCl}_2$ /concentrated  $\text{HCl}$ , conversion of alcohols into aldehydes and ketones.

**Ethers:** Preparation by Williamson's Synthesis; **Aldehydes and Ketones:** oxidation, reduction, oxime and hydrazone formation; aldol condensation, Perkin reaction; Cannizzaro reaction; haloform reaction and nucleophilic addition reactions (Grignard addition); **Carboxylic acids:** formation of esters, acid chlorides and amides, ester hydrolysis; **Amines:** Preparation from nitro compounds, reaction with nitrous acid, azo coupling reaction of diazonium salts of aromatic amines, Sandmeyer and related reactions of diazonium salts; carbylamine reaction;

**Carbohydrates:** Classification; mono- and di-saccharides (glucose and sucrose); Oxidation, reduction.

**Amino acids and peptides:** General structure (only primary structure for peptides) and physical properties.

**Properties and uses of some important Polymers:** Natural rubber, cellulose, nylon, teflon and PVC.

### (c) Mathematics

**Algebra:** Algebra of complex numbers, modulus and argument, triangle inequality,  $n$ th roots of unity. Theory of quadratic equations and quadratic expressions, relationship between the roots and coefficients, sign of a quadratic expression, greatest and least values of quadratic expression. Arithmetic geometric and harmonic progressions, sums of arithmetic, geometric and harmonic progressions, Infinite geometric series, sums of the squares and cubes of the first  $n$  natural numbers. Mathematical induction, permutations and combinations, Binomial theorem for a positive integral index. Determinants of order two and three, solutions of simultaneous linear equations in two and three variables.

**Trigonometry:** Trigonometric functions and their graphs, addition and subtraction formulae, formula involving multiple and sub multiple angles, general solution of trigonometric equations, relations between the sides and angles of triangle, properties of a triangle, solutions of triangles, heights and distances, trigonometric functions.

**Analytical Geometry of Two Dimensions:** Equation of straight line in various forms, angle between two lines, distance of a point from a line, line through the point of intersection of two given lines, concurrency of lines. Equation of a circle in various forms, equations of tangent and normal, intersection of a circle with a straight line, equation of a circle through the points of intersection of two circles and that of a circle and a straight line. Equations of the conic sections in the standard form, focus, directrix, eccentricity of the conic section, parametric equations, equations of tangent and normal

**Calculus:** Into, onto and one-to-one functions, Sum, difference, product and quotient of two functions, composite function; absolute value, greatest integer, polynomial, rational, trigonometric, exponential and logarithmic functions, even and odd functions, inverse of a function. Limit and continuity of a function, limit and continuity of the sum, difference, product and quotient of two functions, continuity of composite function. Derivative of a function, derivative of composite and implicit functions, derivatives of polynomial, rational, trigonometric, inverse trigonometric, exponential and logarithmic functions. Geometrical interpretation of derivative, tangents and normal. Monotonicity, maximum and minimum values of a function. Derivatives upto order three.

**Integration, Differential Equations:** Integration as the inverse proves of differentiation, integration by parts, integration by the methods of substitution and partial fraction, Definite integral and its application for the determination of areas. Properties of definite integrals. Formational of differential equations. First order equation, variables separable and homogeneous equations.

**Probability:** Addition and multiplication laws of probabilities, conditional probabilities.

**Vectors:** Addition and vectors, scalar products, cross product, scalar and vector triple products, applications in geometry.

## SAMPLE QUESTIONS

### PHYSICS

1. Planck's constant has the dimensions of  
a) Energy    b) Mass    c) Frequency    d) Angular momentum
2. The light travels as  
a) Longitudinal waves    b) Mechanical waves  
c) Transverse waves    d) Stationary waves
3. The photoelectric effect is based upon the law of conservation of  
a) Momentum    b) Energy  
c) Angular momentum    d) Mass

## CHEMISTRY

1. What will be the molarity of a solution, which contains 5.85 g of NaCl(s) per 500 mL?  
a)  $4 \text{ mol L}^{-1}$     b)  $20 \text{ mol L}^{-1}$     c)  $0.2 \text{ mol L}^{-1}$     d)  $2 \text{ mol L}^{-1}$
2. The shape of  $IF_7$  molecule is  
a) Octahedral    b) Tetrahedral  
c) Trigonal bi-pyramidal    d) Pentagonal bi-pyramidal
3. Which of the following is an alicyclic compound?  
a) Benzene    b) Hexane    c) Cyclohexane    d) Furon

## MATHEMATICS

1. The value of  $\cos 20^\circ \cos 40^\circ \cos 60^\circ \cos 80^\circ$  is  
a)  $1/8$     b)  $1/20$     c)  $1/16$     d)  $1/32$
2. How many numbers having 6 digits, which are not divisible by 5, can be formed from the digits 4, 5, 6, 7, 8, 9, no digit being repeated?  
a) 720    b) 120    c) 620    d) 600
3. In an ellipse, the distance between its foci is 6 and minor axis is 8. Then its eccentricity is  
a)  $3/5$     b)  $1/2$     c)  $4/5$     d) 7