B. SC. CHEMISTRY (Subsidiary)

1st Year 1st Semester

PAPER	UNIT	PERIODS/WEEK	MARKS
IS	PC/S-101, OC/S-101, IC/S-101	2+2+2	50
IIS	PC/S-102, OC/S-102, IC/S-102		50
Chemistry Laboratory : IC/S-Lab. I		6	

1st Year 2nd Semester

PAPER	UNIT	PERIODS/WEEK	MARKS
IIIS	PC/S-103, OC/S-103, IC/S-103	2+2+2	50
IVS	PC/S-104, OC/S-104, IC/S-104		50
Chemistry Laboratory : IC/S-Lab. II		6	50+50 [For two semesters]

2nd Year 1st Semester

PAPER	UNIT	PERIODS/WEEK	MARKS
VS	PC/S-201, OC/S-201, IC/S-201	2+2+2	50
VIS	PC/S-202, OC/S-202, IC/S-202		50
Chemistry Laboratory : IC/S-Lab. III		6	

2nd Year 2nd Semester

PAPER	UNIT	PERIODS/WEEK	MARKS
VIIS	PC/S-203, OC/S-203, IC/S-203	2+2+2	50
VIIS	PC/S-204, OC/S-204, IC/S-204		50
Chemistry Laboratory : OC/S-Lab. I		6	50+50 [For two semesters]

GRAND TOTAL ⟶ 600

Note : IC/S = Inorganic Chemistry (Subsidiary), OC/S = Organic Chemistry (Subsidiary), PC/S = Physical Chemistry (Subsidiary).

B.Sc. COURSE PLAN (Subsidiary)

Inorganic Chemistry

1st Year

1st Semester : Paper IS & Paper IIS (Group C each) Marks : 16 + 16

Unit : IC/S – 101 – Atomic Structure and Periodic Table : 15 L

Unit : IC/S – 102 – Periodic Properties of Atoms : 15 L

2nd Semester : Paper IIIS & Paper IVS (Group C each) Marks : 16 + 16

Unit : IC/S – 103 – Chemical Bonding - I : 15 L

Unit : IC/S – 104 – Inorganic Equilibrium - I : 15 L

2nd Year

1st Semester : Paper VS & Paper VIS Marks : 16 + 16

Unit : IC/S – 201 – A. Chemical Bonding – II
B. Atomic Nuclei & Radioactivity : 15 L

Unit : IC/S – 202 – Comparative Study of Group elements - I
(Non-transition elements of Gr. I, II, III & noble gases) : 15 L

2nd Semester : Paper VIIS & Paper VIIIS (Group C each) Marks : 16 + 16

Unit : IC/S – 203 – A. Introduction to Coordination Chemistry
B. Introduction to Transition Metals : 15 L

Unit : IC/S – 204 – Comparative Study of Group elements - II
(Non-transition elements of Gr. IV, V, VI & VII) : 15 L

INORGANIC CHEMISTRY (Subsidiary)

1st Year 1st Semester

Unit : IC/S – 101 **15 L**

Atomic Structure and Periodic Table

A. Bohr's atomic model, its limitations, Zeeman effect,

Spectra of many electron system, etc. – Recapitulation only.

B. The de Broglieconcept of matter wave, the $\lambda = \frac{h}{p}$ equation (simple problems)

C. Quantum mechanical model – Schrodinger equation in spherical coordinate (r, θ) and its solutions for one electron case (only to write down the expressions for the radial, angular parts of s, p orbitals); significance of the n, l, m quantum numbers; probability interpretation of ψ^2; plot of F(…) against (r), shapes of s, p, d,A.O.'s (only drawing); spin motion of electron and the spin quantum number; many electron system and the Pauli exclusion principle, energy level of A. O.'s and writing of the electron configuration of atoms.

D. Long form of periodic Table in the light of electronic configurations; classification of elements as s–p block (the normal elements); d–block (the transition elements) and the f–block (lanthanides, actinides).

Unit : IC/S – 102 **15 L**

Periodic properties of Atoms :

A. The ionisation potentials of atoms – definition, examples; first, second etc. I. P.; variation of the I. P. along the periodic table and explanation of the trends.

B. The electron affinity of atoms – Definition, illustration, variation of the values along the periodic table and explanation of the trends.

C. The atomic radii – The concept of various radii – ionic radii, convalent radii, van der Waal radii, etc, with examples; variation of the atomic radii along the periodic table.

D. The electronegativity (E. N.) – The concept of electronegativity and its difference from electron affinity; E. N. scale, the postulation of arithmetic and geometric mean in the determination of E. N. values, ionic characters of bonds and the E. N. difference, other E. N. scales – the Mulliken, Allred – Rochow scales.

1st Year 2nd Semester

Unit : IC/S – 103 **15 L**

Chemical Bonding – I

A. General introduction to the electronic theory of bonding – the ionic, covalent, coordinate bonding : concept of bond energy; examples.

B. Ionic binding – (i) Energetics of Ionic binding leading to formation of solids; packing of ions, radius ratio effect, representative types of lattice, Born equation, Madelung constant, Born–Haber Cycle – its applications; calculation of ionic radii in crystal from the internuclear distance – examples.

ii) Polarising power and polarisability of ions, Fajan's rule, stabilisation of ions through hydration/solvation.

C. Covalent bonding – the V. B. theory and orbital hydridisation.

i) Qualitative principle of V. B. theory, concept of resonating structures, directional characteristics of covalent bond, hybridisation of A. O., examples of molecules with sp, sp^2, sp^3, d^2sp^3 – hybrid A. O. with angular orientation,

ii) Valence shell electron pair repulsion (VSEPR) theory; Linnett double quartet model; examples.

Unit : IC/S – 104 **15 L**

Ionic equilibrium – I

A. General principle of equilibrium, the equilibrium constant, examples of acid–base–, redox and distribution – (in two phases) equilibria; redox equation and ion–electron method of balancing redox equations.

B. Strength of acids and bases in aqueous solution in terms of K_a, K_b; the pH scale, the poil, pK_w, pK_a, pK_b, etc. Hydrolysis of salts, pH of solutions of salts of strong acid – weak base, weak acid – strong base, weak acid–weak base, multistage equilibria involving salts of polybasic acids; Buffer solutions, calculation of pH of buffer solutions; acid base indicator.

C. Solid – solution equilibrium, the solubility and solubility product (K_{sp}), common ion effect, effect of H^+/OH^- and complexing agents. Application of the concept of Ksp in qualitative analysis; calculation on pH condition and precipitation.

2nd Year 1st Semester

Unit : IC/S - 201 **15 L**

A. Chemical Bonding II

(Introduction to M. O. theory)

i) The concept of molecular orbital, LCAO – MO, positive overlap of atomic orbitals leading to bond formation, negative overlap leading to antibonding; σ, Π, δ – type overlap.

ii) Energy level diagram for homonuclear diatomatic molecules like H_2, He_2, Li_2, Be_2, B_2, C_2, O_2, O_2^+, O_2^-, F_2 NO_2, also the isoelectronic analogues; bond–order concept.

iii) Energy level diagram for heteronuclear diatomic molecules – LiH, NO, NO^+, NO^-, CO, HF.

B. Atomic Nuclei and Radioactivity

i) Natural Radioactivity – α, β, γ - emission, disintegration rate, half life, radioactive equilibrium, units of radioactivity (problems), radioactive series.

ii) Composition of the nuclei, isotope, isobar, isotone, isomer, nuclear binding energy, packing fraction, n/p ratio and nuclear stability, elementary idea of nuclear reactions, comparison between nuclear reaction and chemical reaction.

Unit : IC/S – 202 **15 L**

Comparative study of group elements – I

(Nontransition elements of Gr. I, II, III and noble gases)

i) The general trends in properties of alkali and alkaline earth metals; their reactions with H, C, N, O and hydrolytic behaviour of the products.

ii) Metallurgy of Li, Be and Ra.

iii) Isotopes of hydrogen, large scale preparation of deuterium, its reactions, uses; ortho–para hydrogen.

iv) General properties of Ge. III elements; chemistry of boron – preparation, properties and structures of diborane, borazine; boron and aluminium haldes and their polymerization.

v) The noble gases – their separation and uses. Compounds of Kr and Xe – preparation, structures (bonding excluded).

2nd Year 2nd Semester

Unit : IC/S – 203 **15 L**

A. Introduction to Coordination Chemistry

i) Historical account – the cobaltammines, Werner's theory, explanation of the structures of cobaltammines with Werner's theory; equivalence of primary and secondary valency with ionic and covalent bond respectively.

ii) The ligands – examples of mono– and polydentate ligands (anionic, neutral, cationic) with structures showing the coordinating sites.

iii) IUPAC nomenclature of coordination compounds including the polynuclear ones; examples.

iv) Structure of coordination compounds from the orbital hydridisation of the central atoms– linear (sp), square planar (dsp^2), tetrahedral (sp^3), trigonal bipyramid (dsp^3), octahedral (d^2sp^3), etc.; examples.

v) Isomerism of different types (geometrical, optical and others).

B. Introduction to transition metals :

i) General characteristics – the electronic configuration, high m.p., b.p., density; variable valency; complex formation; magnetic and optical properties of the compounds, etc.

ii) The extractive metallurgy of Au (cyanide process), Ni (Mond's process), Ti (Kroll process) and the chemistry of Ti.

Unit : IC/S – 204 **15 L**

Comparative study of group elements – II

(Non–transition elements of Gr. IV, V, VI, VII).

Gr. IV : The general group properties and chemistry of Si – the silanes, silicones, the silicates (elementary idea of structures).

Gr. V : The general group properties and chemistry of N and P – preparation, properties, structures, bonding of hydrazine, hydroxylamine, hydrazoic acid; oxides and oxyacids of P.

Gr. VI : The general group properties and Chemistry of S – the oxides and oxyacids of sulphur – preparation, properties, structures, bonding.

Gr. VII : The general group properties and oxides and oxyacids of halogens, the interhalogen compounds – preparation, properties, structures, bonding.

CHEMISTRY (Subsidiary) Practical

(INORGANIC CHEMISTRY)

1st Year (1st Semester + 2nd Semester)

Unit : IC/S – Lab. I + IC/S – Lab. II

1. Inorganic Reaction Chemistry Qualitative analysis.
   Same as the Honours Syllabus excepting that the detection of SiO_4^{4-} is excluded here.
2. Preparation of standard $K_2Cr_2O_7$ and standardisation of Mohr's salt with it.

2nd Year 1st Semester

Unit : IC/S – Lab. III

1. Qualitative detection of unknown salts containing not more than 3 radicals from among the cations and anions learnt in the first year class but excluding sulphur – acid and halide ion separations.
2. Estimation of Fe^{3+} and Cu^{2+}.

ORGANIC CHEMISTRY (Subsidiary)

1st year 1st Semester

Unit: OC/S-101 **15L**

A. Structure, Bonding and Reactivity of Organic Molecules:

Hybridization, bond length, bond angle, localized and delocalized chemical bonds, M.O. concept of bonding, electronegativity concepts, dipole moment, bond polarization, inductive effect, resonance, electromeric effect, hyperconjugation, steric effect.

B. General Idea about Organic Reaction Mechanism:

Drawing of electron movements with arrows, homolytic and heterolytic bond breaking, types of reagents – eletrophiles and nucleophiles, types of organic reactions. Energy Considerations, Reactive intermediates – Carbocations, Carbanions, Free Radicals, Carbenes and Nitrenes. Methods of determination of reaction mechanism – product analysis, intermediates, isotope effects, kinetic and stereochemical studies.

C. Strength of Organic acids and bases.

Unit: OC /S – 102 **15L**

A. Stereochemistry of Organic Molecules:

Stereoisomerism, elements of symmetry, molecular chirality, stereogenic centres, enantiomers, diastereomers; Configurational notations - D & L, R & S, *cis* and *trans*, E & Z; conformational analysis of ethane and n-butane, Newman and sawhorse formulae.

B. Chemistry of Alkanes, Alkenes and Alkynes:

Preparations and Reactions. Detailed studies on i) elimination reactions, ii) addition reactions of alkenes and alkynes; iii) polymerization of alkenes.

1st year 2nd Semester

Unit: OC/S - 103 **15L**

A. Arenes and Aromaticity:

Structure of benzene, aromaticity, Huckel Rule, Simple examples of non-benzenoid aromatics, aromatic electrophilic substitution, orienting effect, homologues of benzene.

B. Alkyl and Aryl halides:

Preparations and Reactions with special emphasis on S_N1, S_N2, S_Ni, S_NAr, elimination-addition pathways; polyhalogen compounds – DDT, BHC.

Unit: OC/S - 104 **15L**

A. Alcohols and Thiols:

Preparations and Reactions of mono-, di- and trihydric alcohols, thiols, dithiols and thioethers. Distinction between the three classes of alcohols.

B. Aldehydes and Ketones:

Preparation and Reactions of Aliphatic and Aromatic Aldehydes and Ketones.

2nd year 1st Semester

Unit: OC/S – 201 **15L**

A. Phenols and Sulphonic Acids:

Preparations and Reactions of mono-, di- and trihydric phenols, Sulphonation of benzene derivatives and properties and reactions of sulphonic acids.

B. Ethers and Epoxides:

Preparation and Reactions – Emphasis on ether cleavage and epoxide ring opening.

C. Carboxylic Acids and Their Derivatives:

Preparations, Properties and Reactions of Aliphatic and Aromatic Carboxylic acids (mono and di), acid chlorides, anhydrides, esters and amides.

Unit: OC/S – 202 **15L**

A. Organic Compounds of Nitrogen:

Preparation and Reactions of Aliphatic and Aromatic amines, nitro-compounds, cyanides, isocyanides, diazonium salts and diazo-coupling.

B. Spectroscopy:

Preliminary idea of UV and IR Spectroscopy.

2nd Year 2nd Semester

Unit: OC/S – 203 **15L**

A. Organometallic Compounds:

Organomagnesium (Grignard Reagent), Organozinc (Reformatsky) and Organolithium compounds – Preparations and Reactions.

B. Organic Synthesis via Enolates:

Idea of Tautomerism, Synthetic applications of ethyl acetoacetate, ethyl cyanoacetate and diethyl malonate.

C. Amino Acids and Peptides:

Classification, Structure and Stereochemistry of amino acids, acid-base behaviour and isoelectric point, preparations and reactions of α–amino acids, preliminary idea of peptides.

D. Fats, Oils and Detergents:

Natural Fats, edible and industrial oils of vegetable origin, glycerides, Saponification value, iodine value, acid value, soaps and synthetic detergents.

E. Polymers:

Addition polymerization, Ziegler–Natta Catalyst; Condensation Polymerization – polyesters, polyamides, phenol-formaldehyde resin, natural and synthetic rubber.

Unit: OC/S – 204 **15L**

A. Heterocylic Compounds:

Introduction, preparation and reactions of pyrrole, furan, thiophene and pyridine.

B. Naphthalene:

Isolation from coal tar, synthetic methods, reactions of naphthalene.

C. Synthetic Dyes:

Colour and constitution, classification of dyes, chemistry and synthesis of methyl orange, congo red, malachite green, phenolphthalein, fluorescein and indigo.

D. Carbohydrates:

Classification and nomenclature, monosaccharides, osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses, glycoside formation, introduction to disaccharides.

Organic Chemistry Practical

2nd Year Chemistry Subsidiary

Unit: OC/S – Lab - I

1. Crystallisation of benzoic acid and acetanilide (both from hot water) and determination of melting points of the crystalline materials.

2. Distillation of carbon tetrachloride : Determination of its boiling point.

3. Determination of mixed melting points (urea + cinnamic acid)

4. Qualitative Analysis of Organic Compounds : Detection of special elements (N, S and halogens) and functional groups in organic compounds.

5. Preparation of Organic Compounds

   a) Acetanilide b) *p*-Bromoacetanilide

   c) Salicylic acid (from Anthranilic Acid)

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PHYSICAL CHEMISTRY (Subsidiary)

1st Year 1st Semester

Unit : PC/S-101 **15L**

Gases

Kinetic theory of gases: Postulates, derivation of the expression for pressure, derivation of the empirical laws.

Real Gases : Deviations from ideal behaviour, Boyle temperature, Van der Waal's equation of state, isothermals of real gases and Van der Waal's gas, continuity of state-critical states-evaluation of critical constants-law of corresponding states, other equations of state, molecular weight by limiting density method.

Unit : PC/S-102 **15L**

Liquid :

Intermolecular forces, heat of vaporization, vapour pressure, coefficients of thermal expansion and compressibility, viscosity determination and influence of temperature.

Surface tension-capillary rise method-determination and influence of temperature on surface tension.

Solid :

Types of solid, crystal forces close packed structure, radius ratio rules, crystal classes-crystal symmetry-Bragg's equation and heat capacity of solids.

1st Year 2nd Semester

Unit : PC/S-103 **15L**

Thermodynamics :

First Law : Reversible and irreversible processes, isothermal and adiabatic processes, heat, work, energy and enthalpy, heat capacities, Jule-Thompson effect.

Thermo chemistry :

Laws of thermo chemistry, determination of heat of reaction in a calorimeter. Heat of formation, bond dissociation energy and bond energy, Kirchoff's equation.

Unit : PC/S-104 **15L**

Chemical Kinetics :

Rate of chemical reaction, distinction between order and molecularity of reaction, first and second order rate equations with examples – some idea in fractional orders-determination of order of reaction, influence of temperature on rate constant, catalysis.

2nd Year 1st Semester

Unit : PC/S-201 **15L**

Thermodynamics:

Second law of thermodynamics-entropy and free energy concepts, free energy and chemical equilibrium.

Unit : PC/S-202 **15L**

Solutions :

Henry's law, Raoult's ;aw. Colligative properties (Osmotic pressure, depression of freezing point, evaluation of boiling point, lowering of vapour pressure), their determinations, abnormal behaviour.

Phase Equilibrium :

Phase rule and its applications to one component and simple two component systems, Nernst distribution law-Association and Dissociation phenomena.

2nd Year 2nd Semester

Unit : PC/S-203 **15L**

Electrochemistry :

Conductance by Wheatstone bridge principle, specific conductance, equivalent conductance, molecular conductance, cell constant, Kohlraush's law, application of conductance measurements. Emf of galvanic cells. Some idea on hydrogen and quinhydrone electrodes. Nernst equation and standard electrode potential, application of emf measurements.

Unit : PC/S-204 **15L**

Surface Chemistry :

Adsorption phenomena : Physical adsorption and chemical adsorption, Freundlich and Langmuir adsorption isotherm, surface catalysis.

Colloids :

Preparation and purification of colloids, lyophobic and lyophilic colloids, general properties-electrical, optical, sedimentation properties, Brownian motion, Schulze Hardy valency rule, stability of colloids. Some preliminary ideas on electrokinetic phenomenon.