2011-12
[S-5]

BANGALORE UNIVERSITY

B.Sc. Chemistry Syllabus

for

I to VI Semesters

(w.e.f. 2011)

Department of Chemistry
Central College Campus, Bangalore - 560 001

Proceedings of the meeting of the Board of Studies in Chemistry (UG) held on 14th June 2010 in the Department of Chemistry, Central College Campus, Bangalore University, Bangalore-560001.

A meeting of the Board of Studies in Chemistry (UG) was held on Monday, the 14th of June 2010 at 10.30 am in the department for constitution of BOE and preparation of Panel of Examiners in respect of UG (B.Sc Chemistry & Biochemistry, Annual and Semester schemes) and professional course (B.E.Engineering chemistry) examinations of 2010-2011 and also to discuss about introduction of MCQ pattern of question papers for 3 year B.Sc degree course and for the approval of the draft syllabus prepared for 3 year B.Sc course to be introduced from 2010 onwards.

The Chairman welcomed the members and as per the agenda item one, placed before them the list of examiners submitted by the various colleges in response to the University Notification Vide notification No. EX-I/BOS panel/UG/PG Exams/Annual & semester/2010-2011 dated:06-02-2010. The chairman also provided the members with the lists of BOE constituted for the three previous academic years viz, 2007-08, 2008-09 & 2009-10 in respect of the above three courses and requested the members to constitute the BOE and panel of examiners in the light of the above for the 2010-2011 for B.Sc. Chemistry (Annual & Semester scheme) and B.E (Engineering Chemistry) examination of 2010-2011.

Since the BOS in Biochemistry has not yet been constituted the BOS in chemistry constituted the BOE and prepared the panel of examiners for B.Sc Biochemistry examinations of 2010-2011 as per the request of the Chairman, Department of Biochemistry.

The members after careful scrutiny constituted the BOE and prepared the panel of examiners for the B.Sc Chemistry, B.Sc Biochemistry and B.E (Engg. Chemistry) Examinations 2010-2011.

The BOS also ratified the consolidated list of examiners submitted by Dr. Bulbule, Chairman, BOE in Chemistry (2009-10 exam) as per the request of the Chairman, BOE for May/June exam of 2010.

The Chairman briefed the members about the second agenda, i.e the introduction f MCQ pattern for B.Sc degree examination and preparation of question paper in the new format for that. The matter was discussed at length in the meeting. The pros and cons of all the related aspects were also discussed. The board in principle agreed for the introduction of MCQ pattern, but unanimously resolved to request the University authorities to conduct a workshop with a larger group of teachers of all subjects involving UG (BOS) members and UG (BOE) members also to discuss the implications of introduction of MCQ pattern and to come out with a concrete solution at the earliest. BOS recommends to implement the introduction of MCQ pattern after a thorough discussion.

Then the third agenda was taken up for discussion. The Chairman informed the members that as per the direction from Bangalore University, the Chemistry syllabus for the B.Sc degree had to be revised which are proposed to be introduced from 2010 onwards. In this connection, the DOS in Chemistry, Bangalore University, Bangalore with the help of Chemistry Teacher's Forum constituted a core committee from University department and affiliated Colleges. The core group participated in workshops held on three days 11th March 2010, 30th March 2010 and 7th

April 2010 and prepared a draft copy of the revised syllabus. The syllabus was then finalized in a workshop conducted on 12th May 2010 in the presence of a wider group of Teachers represented by most of the colleges offering Chemistry at UG level. It is this syllabus that is placed before the board for scrutiny and approval.

The Board unanimously approved the syllabus after some modification.

The BOS also recommends to the University to constitute a BOS (UG) in Biochemistry as Biochemistry department is bifurcated from Chemistry department.

The Chairman finally thanked all the members for their presence and their valuable inputs for the deliberations of the day.

1.	Dr. Anantha, C	(Member)	Anantha.C.
2.	Prof.Nusarath Zareen	"	
3.	Prof. Shivaiah	"	Retired
4.	Prof. Chikkanna	"	
5,	Dr. Halesh, R	"	
6.	Prof. Girija, M. S	"	
7.	Dr. C. Krishna Kumar	"	
8.	Prof. Ramesh Babu A.	"	
09.	Prof. Siddaramappa B.R.	"	
10.	Prof. K. N. Mahendra (Chairman)		14/6/

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Members of the Committee for the Revision of Chemistry Syllabus for B.Sc. degree course (Semester Scheme)

Department of Chemistry: Central College Campus, Bangalore University, Bangalore.

Prof. K. N. Mahendra
Chairman, DOS in Chemistry
Bangalore University, Central College Campus, Bangalore – 560 001

Inorganic Chemistry Section

Prof. K. R. Nagasundar, Central College, Bangalore

Dr. V. G. Gayathri, Central College, Bangalore

Organic Chemistry Section

Prof. M A. Pasha, Central College, Bangalore

Dr. Hariprasad, Central College, Bangalore

Physical Chemistry Section

Prof. M. Farooq Ahmed, Central College, Bangalore

Prof. L. Gomathi Devi, Central College, Bangalore

Biochemistry Section

Dr. V. R. Devaraj, Central College, Bangalore

Organiser

Dr. R. Ramachandrappa
President, Chemistry Teachers' Forum, Jyotinivas College, Bangalore

Coordinator

Dr. A. Sreenivasan, National College, Basavanagudi, Bangalore

Physical Chemistry Section

Dr. Nandeesh, SJRC College, Bangalore
Mr. Ananth, MES College, Bangalore
Dr. Chenne Gowda, VV Puram Science College, Bangalore
Mr. C. Nagaraju National College, Gowribidanuru
Dr. N. C. Subramanyam, APS College, Bangalore
Dr. Shahintaj, Al Ameen, College, Bangalore
Dr. Girija, SSMRV College, Bangalore
Ms. Mythili, Maharani Science College, Bangalore

Inorganic Chemistry Section

Mr. Aswanthanarayanappa, National College, Jayanagar, Bangalore
Dr. Donappa, MLA College, Bangalore
Mr. Ramanna, Kongadiappa College, Doddaballapura
Mr. Bulbule, KLE College, Bangalore
Dr. Nagaraju, St. Joseph College, Bangalore
Mr. Jugalle, Govt. First Grade College, K R Puram, Bangalore
Dr. Muddu Krishna, Maharani College for Women, Bangalore
Mr. Shivappa Notagar, Vijaya College, Basavanagudi, Bangalore

Organic Chemistry Section

Mr. Arunachalam, National College, Basavanagudi, Bangalore
Dr. M. Ramaiah, NMKRV College, Bangalore
Mr. Ramesh Babu, Vijaya College, Basavanagudi, Bangalore
Mr. Devaraju, Kuvempu College, Chennapattana
Mr. Nataraja, Maharani Science College, Bangalore
Mr. Chandargi, Govt. Science College, Bangalore
Mr. L. K. Srivatsa, Vijaya College, Jayanagar, Bangalore

Biochemistry Section

Mr. Ashraf Ali, Al Ameen College, Bangalore
Ms. Manjula, Vijaya College, Basavanagudi, Bangalore
Dr. Nanda, BMS College for Women, Bangalore
Mr. Prabanjan Kumar, APS College, Bangalore
Ms. Malini Nagaraju, Jyothi Nivas College, Bangalore
Mr. Venkata Reddy, VV Puram Science College, Bangalore

Proceedings of the Meeting of Board of Studies in Chemistry (UG) held on Monday, the 14th June 2010 at 10.30 am in the Department of Chemistry, Central College Campus, Bangalore-560 001.

The Chairman welcomed the members of the Board to the meeting and introduced them. He placed the agenda for the day's discussion.

Agenda: *Scrutiny and approval of the Draft Syllabus for B.Sc, Chemistry Semester Scheme.*

The Chairman informed the members that as per the directive from Bangalore University, the Chemistry syllabus for the B. Sc. degree had to be revised which is proposed to be introduced from 2010 onwards. In this connection, the Department of Studies in Chemistry, Central College with the help of Chemistry Teachers' Forum constituted a Core Group form University Department and affiliated Colleges. The Core Group participated in a work shop held for three days on 22.03.2010, 30.03.2010 and 07.04.2010 and prepared a Draft of the revised syllabus. The syllabus was then finalized in a workshop conducted on 12th May 2010 in the presence of a wider group of Teachers represented by most of the colleges offering Chemistry at UG level. It is this draft that is placed before the Board for Scrutiny and approval.

The Board approved the Syllabus after some modification.

FOREWORD

As per the directive from Bangalore University, the Chemistry syllabus for the B.Sc., degree course had to be revised. Guidelines for this were provided by the Task Force Committee constituted by the University.

The Department of Studies in Chemistry, Central College, with the help of the Chemistry Teachers' Forum, constituted a Core Group involving the Teachers of the University Department and affiliated colleges. This Core Group, consisting of about forty teachers participated in a work shop held three days on 22.03.2010, 30.03.2010 and 07.04.2010 and prepared a draft syllabus keeping in view the aims of the UGC Model Curriculum in developing interdisciplinary skills in students linking general studies with professional courses and allowing both vertical and horizontal mobility and also catering to local needs.

Teachers of different branches of Chemistry, namely Inorganic, Organic, Physical and Biochemistry had separate and joint brainstorming sessions and arrived at a Draft Syllabi in Chemistry for six semesters. A paper in Biochemistry has been included in the Chemistry syllabus because it was felt that students would benefit by exposure to this interdisciplinary area.

The Chemistry Teachers' Forum played a pivotal role during the drafting of the syllabus. The Draft Syllabi in chemistry was brought to the attention of a wider group of Teachers for further refinement on 12th May 2010. The final draft incorporating the suggestions was placed before the Board of Studies in Chemistry and was approved after same modification.

CHAIRMAN
Department of Studies in Chemistry
Bangalore University
Bangalore-560 001

Structure of B.Sc. Degree Course (Triple Main/Major)

CHEMISTRY

Semester	Title of the Paper	Teaching hours/week	Duration of Examination	Marks Allotment		Total Marks
				Internal Assessment	Theory	
I	Chemistry-1 (*General*)	4	3	10	60	70
	Practical-1 (*General*)	3	3	-	30	30
II	Chemistry-2 (*General*)	4	3	10	60	70
	Practical-2 (*Physical*)	3	3	-	30	30
III	Chemistry-3 (*General*)	4	3	10	60	70
	Practical-3 (*Organic*)	3	3	-	30	30
IV	Chemistry-4 (*General*)	4	3	10	60	70
	Practical-4 (*Inorganic*)	3	3	-	30	30
V	Chemistry-5 (*Organic*)	3	3	10	60	70
	Chemistry-6 (*Physical*)	3	3	10	60	70
	Practical-5 (*Organic*)	3	3	-	30	30
	Practical-6 (*Physical*)	3	3	-	30	30
VI	Chemistry-7 (*Inorganic*)	3	3	10	60	70
	Chemistry-8 (*Biochemistry*)	3	3	10	60	70
	Practical-7 (*Inorganic*)	3	3	-	30	30
	Practical-8 (*Biochemistry*)	3	3	-	30	30

B.Sc. - I Semester

(Paper – I)

Contents

Chapter No.	Title	Number of Teaching hours
1	Mathematical Concepts for Chemistry	4
2	Quantum Mechanics and Atomic Structure	10
3	Periodic Table and Periodic Properties	10
4	Oxidation Numbers	3
5	Non-aqueous solvents	2
6	Liquids and Solutions	9
7	Classification and Nomenclature of organic compounds	3
8	Basic concepts in organic chemistry	4
9	Aliphatic hydrocarbons	10
	Total	55

B.Sc. - I Semester

Chapter 1: Mathematical Concepts for Chemistry — 4 hours

Logarithmic relations: Definition, some important relations like $\log(m+n)$, $\log\left(\frac{m}{n}\right)$, $\log m^n$, change of base ($\log_e 2 \rightarrow \log_e x$). Application in the calculation of pH.

Curve sketching: How a cure is sketched with a set of points: linear and non-linear (asymptotic) with a set of points, sketching both linear and non-linear curves. Calculation of slope in the case of linear curve. Extrapolation of linear curve and arriving at a limiting value.

Parabolic curve- maximum and minimum.

Differentiation: Meaning and derivative of functions like e^x, $\log x$, $\sin x$, $\cos x$, $\frac{1}{x}$, x^2, x^x and $\sqrt{n}$, $\frac{dy}{dx} = 0$ at maximum and minimum.

2nd order differentiation: for maximum and minimum (derivation from first principles not required). Rules of differentiation for $y = u + v$, $y = uv$, $y = \frac{u}{v}$ and $y = ku$, where k is constant.

Partial differentiation: Explanation, applications using the equation, H = U + PV and G = H – TS.

Integration: Meaning and integrals of functions like, x, dx, x^2, $\frac{1}{x}$, $\frac{1}{x^2}$, $\frac{1}{x^3}$, x^n, e^x, $\sin x$ and $\cos x$. simple problems from I and II order kinetics.

Exact and inexact differentials: Examples from internal energy and enthalpy.

Definite integrals.

Permutations and combinations-A brief introduction.

Probability: some definitions, examples from atomic orbitals, wave functions and entropy.

Chapter 2: Quantum Mechanics and Atomic Structure — 10 hours

Bohr's atomic model: (i) Assumptions, (ii) Derivation of expressions of for radius, energy and wave number for the hydrogen atom. (iii) Calculation of wave numbers of spectral lines of different series in the hydrogen spectrum. (iv) Calculation of ionisation energies of hydrogen like atoms. (v) Interpretation of the origin of discrete specrum. Defects of Bohr's atomic model. de-Broglie's hypothesis. Heisenberg's uncertainity principle.

New Quantum Mechanics: Sinusoidal wave equation (classical wave mechanics); Schroedinger wave equation-interpretation of the terms: (i) hamiltonian operator (ii) eigen function Ψ (significance of ψ and ψ^2) (iii) eigen values.

Application of Schrodinger equation: (i) to particle in one dimensional box (ii) to the hydrogen atom (detailed solution not required). Expressing the solution as a product of $\psi_{n,l,m}(r, \theta, \phi) = \psi_{n,l}(r)\,\Psi_{l,m}(\theta, \phi)$

Explanation of quantum numbers (only qualitative). Radial probability distribution and angular probability distribution. Orbitals-shapes of s, p and d orbitals. Pauli's exclusion principle, Hund's multiplicity rule, aufbau principle, electronic configuration of elements (upto atomic number 60).

Chapter 3: Periodic Table and Periodic Properties **10 *hours***

Modern Periodic law, classification of elements in the long form periodic table into *s*, *p*, *d* and *f*-blocks, outer shell electronic configuration of these blocks.

Atomic and ionic radii, ionization energy, electron affinity and electronegatvity - definition, methods of determination of electronegativity (Pauling's and Mulliken's method), trends in the periodic properties and applications in predicting and explaining chemical behavior. Comparative study of elements of groups 1, 2, 16 and 17, with respect to electronic configuration, atomic and ionic radii, ionization energy and electronegativity. Compounds of groups 1 and 2 (halides, oxides and carbonates). Diagonal relationship between Be and Al. Hydrides of groups 16 and 17.

Chapter 4: Oxidation Numbers **3 *hours***

Definition, difference between valency and oxidation number, computation of oxidation numbers, balancing of red-ox reactions by ion-electron method, calculations of equivalent weight of oxidizing and reducing agents.

Chapter 5: Non-aqueous solvents **2 *hours***

Liquid ammonia and liquid sulphur dioxide - solvent properties and typical reactions.

Chapter 6: Liquids and Solutions **9 *hours***

Properties of liquids: Surface tension and its determination using stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald's viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Solutions of liquids in liquids: Thermodynamics of ideal solutions and Raoult's law.

Non-ideal solutions: Vapour pressure-composition and temperature composition curves of ideal and non-ideal solutions. Distillation of solutions-Lever rule, azeotropes. Partial miscibility of liquids. Critical solution temperature. Immiscibility of liquids. Principle of steam distillation, Nernst distribution law and its application. Solvent extraction.

Solutions of gases in liquids: Henry's law of gas solubility and its applications

Solutions of solids in liquids: Colligative properties - Review of colligative properties, Raoult's law of relative lowering of vapour pressure and its limitations. Determination of molecular mass of a solute by (i) Berkeley-Hartley's method (π), (ii) Beckmann's method (ΔT_f) and (iii) Landsberger's method (ΔT_b). Abnormal molecular masses, vant-Hoff's factor i and its significance.

Chapter 7: Classification and Nomenclature of organic compounds **3 *hours***

Introduction; classification and IUPAC nomenclature of polyfunctional organic compounds.

Chapter 8: Basic concepts in organic chemistry **4 *hours***

Types of bond cleavage-arrow notations.

Electrophilic and nucleophilic reagents; Electrophiles and nucleophiles.

Electron displacement in organic molecules: Inductive, resonance and hyperconjugative effects.

Reactive intermediates: Generation, structure and stability of carbocations, cabanions, carbon free radicals and carbenes. Assigning formal charges.

Chapter 9: Aliphatic hydrocarbons **10 *hours***

Alkanes: Isomerism. Methods of preparation-Wurtz reaction and Corey-House Reaction. Mechanism of free radical substitution. Reactivity and selectivity of chlorination and bromination.

Conformations of hydrocarbons: Conformation analysis of ethane, propane and *n*-butane. Sawhorse and Newman projection formulae to be used.

Alkenes: Isomerism. Methods of preparation-dehydration of alcohols, dehydrohalogenation of alkyl halides, Wittig reaction-Stereoselectivity.

Reactions of alkenes: Addition of HX. Markownikov's rule; Mechanism of Markownikov's and anti-Markownikov's addition (peroxide effect). Catalytic hydrogenation, Hydroboration-trapping out with aqueous acetic acid, oxymercuration-demercuration. Epoxidation. Mechanism of: (i) Oxidation with $KMnO_4$ and OsO_4; and (ii) Ozonolysis.

Conjugated dienes (Examples with n = 2 & 3): 1, 3-Butadiene: 1, 2 and 1, 4–addition reactions; Diels-Alder reaction : (i) 1,3-butadiene with maleic anhydride, (ii) cyclohexadiene with 1, 2-dichloroethyne.

Alkynes: Methods of preparation-dehydrohalogenation of vicinal and geminal dihalides and higher alkynes from terminal alkynes.

Reactions of alkynes-Electrophilic addition reactions, catalytic hydrogenation, metal-ammonia reduction, oxidation with $KMnO_4$, hydroboration-oxidation and polymerization. Acidic nature of terminal alkynes.

B.Sc. - II Semester

(Paper – II)

Contents

Chapter 1: Chemical Bonding — 13 hours

Ionic bond: Lattice energy, Born - Haber cycle, Born - Lande equation (Derivation not required, problems on Born - Lande expression to be worked out), Calculation of lattice energies of NaCl and MgO, effect of lattice energy on solubility of ionic compounds.

Covalent bond: Valence bond approach; Hybridization and directional characteristics *sp*, sp^2, sp^3, sp^3d, sp^3d^2, shapes of $BeCl_2$, BF_3, $SiCl_4$, PCl_5, SF_6. VSEPR Theory – Shapes of CH_4, NH_3, NH_4^+, H_2O, BrF_3, ICl_2^-. *Molecular Orbital Theory*: H_2, He_2^+, Be_2, N_2, O_2, O_2^-, O_2^{2-}, O_2^+, CO (Bond order, stability and Magnetic properties to be discussed). Polarization concept, Fajan's rules, bond length, bond angle and bond energy, polar and non - polar molecules, dipole moment.

Weak Interactions: *(i) Hydrogen bond* - Intra-molecular and inter-molecular types, anamolous properties of HF, H_2O, NH_3, alcohols, carboxylic acids, nitrophenols and bio-molecules

(ii) *van der Waal's forces* -noble gases and molecular crystals.

Metallic bond - Band theory, electrical properties of metals, semiconductors and insulators.

Chapter 2: Noble gases — 3 hours

Introduction. Isolation of helium from natural gas, applications. Preparation, properties and structures of fluorides and oxides of xenon.

Chapter 3: Compounds of some non-metals — 7 hours

Synthesis, structure and applications of compounds of the following elements:

(i) Boron: boranes (classification), Wades Rule, diborane, boron trifluoride and borazole.
(ii) Nitrogen: hydrazine, hydroxylamine and hydrazoic acid
(iii) Sulphur: thionyl chloride, sulphuryl chloride and sulphur hexafluoride
(iv) Halogens: Bleaching powder and interhalogen compounds - ClF_3, BrF_5, IF_7.

Chapter 4: Silicates — 2 hours

Structure of SiO_4^{4-}, classification of silicates. Zeolites-their structure and applications.

Chapter 5: Thermodynamics — 14 hours

Definition of terms in thermodynamics: Types of variables, intensive and extensive properties. Types of systems - open, closed and isolated systems. Types of processes-isothermal, adiabatic, reversible and irreversible processes. Thermodynamic equilibrium. State functions, exact and inexact differentials. Concept of internal energy (the symbol U to be used), heat and work.

First law of thermodynamics: significance of internal energy and enthalpy. Work done in isothermal and adiabatic expansion and compression of an ideal gas (IUPAC sign conventions to be used).

Heat capacity of a gas at constant pressure and constant volume: relation between P, V and T in an adiabatic process to be derived. Derivation of Kirchoff's equation. Numerical problems.

Second law of thermodynamics: Limitations of I law of thermodynamics with illustrations. Need for II law of thermodynamics, different ways of stating II law with respect to heat and spontaneity. Spontaneous and non-spontaneous processes. Other forms of II law of thermodynamics. Concept of entropy and its significance-illustrations with order, disorder, physical and chemical processes and probability.

Heat engine-Carnot's cycle and derivation of the expression for its efficiency. Problems based on efficiency equation. II law in terms of efficiency (η). Change in entropy in reversible and irreversible processes. Calculation of entropy changes in reversible isothermal and reversible adiabatic processes. Phase transitions (melting point, vaporization, sublimation and polymorphic changes) in terms of entropy. Limitations of the entropy concept of spontaneity.

Gibb's free energy: Work function, chemical potential. Definition and relationship between free energy and work function. Criteria for equilibrium and spontaneous processes. Gibb's-Helmholtz equation-Derivation. Change of free energy with respect to temperature and pressure. Mention of temperature coefficient, van't Hoff isotherm, $\Delta G^\circ = -RT ln K_p$. Problems.

Derivation of van't Hoff reaction isochore and Clausius-Clapeyron equation. Its applications to ΔT_b and ΔT_f determination (thermodynamic derivation not required).

Qualitative treatment of Nernst heat theorem and III law of thermodynamics-statement only. Elementary concept of residual entropy.

Chapter 6: Alicyclic hydrocarbons **2 *hours***

Cycloalkanes: Classification, nomenclature, methods of preparation, chemical reactions.

Chapter 7: Aromatic hydrocarbons **8 *hours***

Nomenclature of benzene derivatives; Kekule structures, resonance structures and molecular orbital theory of benzene, Huckel's rule of aromaticity (Example: cyclopentadienyl anion, cycloheptatrieneyl cation, benzene, naphthalene, anthracene and phenanthrene). Antiaromaticity.

General mechanism of aromatic electrophilic substitution. Orienting influence of substituents in toluene, chlorobenzene, nitrobenzene and phenol; hyperconjugation and resonance effects of these groups; catalytic hydrogenation of aromatic compounds, Birch reduction. Side chain oxidation of toluene to benzaldehyde and benzoic acid. Oxidation of naphthalene, anthracene and phenanthrene. Diels-Alder reaction of anthracene with (i) maleic anhydride, (ii) 1,2-dichloroethene.

Alkenyl benzenes: Styrene, *cis* and *trans*-stilbenes and their preparations.

Biphenyl: Preparation-Ullmann reaction.

Chapter 8: Organic halogen compounds **6 *hours***

Alkyl halides: Introduction and classification: Nucleophilic substitution reactions-S_N1 and S_N2 mechanisms with energy profile diagrams. Effect of (i) nature of alkyl groups, (ii) nature of leaving groups, (iii) nucleophiles and (iv) solvents on S_N1 and S_N2 mechanisms.
Elimination reactions-E1 and E2 mechanisms; Saytzeff and Hofmann eliminations with mechanisms.

Aryl halides: Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution. Generation of benzyne-trapping with dienes (Example: furan and anthracene).

B.Sc. - III Semester
(Paper – III)
Contents

Chapter No.	Title	Number of Teaching hours
1	Chemical Kinetics	8
2	Solid state	9
3	Gaseous State	7
4	Organic and Inorganic Polymers	4
5	General study of *d*- and *f*- block elements	7
6	Metallurgy	5
7	Alcohols and Thiols	7
8	Phenols	3
9	Ethers and Thioethers	3
10	Organometallic compounds	2
	Total	**55**

Chapter 1: Chemical Kinetics **8 hours**

Reaction rates: factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light and catalyst. Order and molecularity of reactions. Mathematical expressions for zero and first order reactions to be assumed. Derivation of expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Expression for half life of a second order reaction. Mean life for first order reaction to be mentioned. Problems on rate constant, half life period, mean life period and order of reaction.

Determination of order of reaction: differential method, method of integration, method of half life period and isolation method.

Theories of reaction rates: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Problems.

Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Steady state approximation and Lindemann's hypothesis.

Experimental determination of kinetics of (i) inversion of cane sugar by polarimetric method, (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

Chapter 2: Solid state **9 hours**

Brief introduction to the structural differences between solids, liquids and gases. Definition of space lattice, unit cell. Laws of crystallography. Symmetry elements in crystals, crystal systems. Weiss and Miller indices. X-ray diffraction of crystals-derivation of Bragg's equation, problems. Determination of the structure of NaCl by rotating crystal method.

Structure of ionic solids based on radius ratio (calculations not required). Coordination number in ionic solids. Structures of NaCl, CsCl, ZnS, CaF_2 and $CaTiO_3$ crystals. Schottky and Frenkel defects. Variation of properties due to defects should be mentioned. F-centers. Gemstones. Non-stoichiometric compounds (FeO, transition metal hydrides). Classification and applications of liquid crystals.

Chapter 3: Gaseous state **7 hours**

Introduction: Need for Maxwell-Boltzmann distribution law, mathematical expression for both mole and molecule-explanation of the terms only. Explanation of velocity distribution curves based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations). Derivation of expression for most probable speed from Maxwell-Boltzmann equation. Definitions and expressions for rms velocity and average velocity, relationships between them. Problems.

Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Derivation of critical constants T_c, P_c and V_c from van der Waal's equation and their experimental determination by Cagniard de La Tour method for T_c and P_c. Amagat's mean density method for V_c. Problems on the calculation of T_c, P_c and V_c, a and b.

Law of corresponding states-statements, reduced equation of state and explanation, Joule-Thomson effect-explanation. Joule-Thomson co-efficient, inversion temperature-definition (no derivation). The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.

Chapter 4: Organic and Inorganic Polymers — 4 hours

Polymerization: Types-addition and condensation polymerization.

Molecular weight of polymers: Expression for weight average and number average. (*Experimental determination is not required*).

Preparation and applications of the following types of polymers:

1. *Plastics*: (i) Thermosetting plastics (phenol-formaldehyde)
   (ii) Thermosoftening plastics (PVC)
2. *Fibers*: Acrylic, polyamide, polyester types-one example for each.
3. *Rubber*: Neoprene.
4. *Fluorocarbons*: Teflon.
5. *Silicones*:

Differences between inorganic and organic polymers.

Chapter 5: General study of *d*- and *f*- block elements — 7 hours

Transition elements: Electronic configuration, atomic and ionic radii, ionization energy, oxidation states, redox potenitials, spectral and magnetic properties, catalytic activity, interstitial compound formation.

Lanthanides and actinides: Electronic configuration, atomic and ionic sizes, lanthanide contraction and its consequences. Oxidation states, spectral and magnetic properties, comparison of oxidation states, complex formation and magnetic properties of *d*- and *f*- block elements. Ion-exchange method of separation of Lanthanides.

Chapter 6: Metallurgy — 5 hours

Ellingham's diagrams: Salient features. Selection of reducing agent using Ellingham's diagrams.

Extraction of the following metals:

(i) Nickel from sulphide ore
(ii) Thorium from monazite sand
(iii) Uranium from pitchblende
(iv) Plutonium from nuclear waste.

Chapter 7: Alcohols and Thiols — 7 hours

Alcohols: Introduction and classification. Methods of preparation-(i) reduction of aldehydes, ketones, acids and esters, (ii) hydroboration-oxidation with alkaline peroxides (iii) hydration of alkenes.

Reactions of alcohols: Acidic nature, esterification, oxidation-Mechanisms of oxidation of alcohols with $KMnO_4$ and $K_2Cr_2O_7$. Comparison of the reactivity of 1°, 2° and 3° alcohols.

Glycols: Preparation from alkenes using OsO_4 and $KMnO_4$ with mechanisms and from epoxides. Oxidation of glycols by periodic acid and lead tetraacetate with mechanisms.

Glycerol: Preparation from propene and oils/fats and uses.

Reactions of glycerol: (i) nitration, (ii) action of concentrated H_2SO_4 and (iii) oxidation by periodic acid.

Thiols: Nomenclature, methods of formation and chemical reactions.

Uses of dithianes. Introduction of umpolung character (reversal of polarity) in carbonyl compounds.

Chapter 8: Phenols — 3 hours

Classification, acidic nature-Comparison of acidic strength of phenol with alcohols and carboxylic acids. Effect of substituents on acidity of phenols. Reactivity and substitution reactions. Mechanisms of Riemer-Tiemann and Kolbe-Schmidt reactions. Pechmann reaction.

Industrial applications of phenols: Conversion of phenol to (i) aspirin, (ii) methyl salicylate, (iii) salol, (iv) salicyl salicylic acid.

Chapter 9: Ethers and Epoxides — 3 hours

Ethers: Methods of preparation-(i) dehydration of alcohols, (ii) Williamson's ether synthesis. Reactions-as Lewis bases (complexation with metal ions), cleavage and auto-oxidation-Ziesel's method.

Epoxides: Preparation using per acids, Darzen's reaction. Reactions of mono and 1, 2-disubstituted epoxides with (i) carbon nucleophiles, (ii) nitrogen nucleophiles, (iii) reduction with $LiAlH_4$.

Chapter 10: Organometallic compounds — 2 hours

Preparation and synthetic applications of Grignard reagents, Organolithium compounds and lithium dialkyl cuprates.

B.Sc. - IV Semester
(Paper – IV)
Contents

Chapter 1: Phase Equilibria — 7 hours

Statement and explanation of the terms with examples for phase (P), component (C) and degree of freedom (F), Definition and significance of phase rule. Application of phase rule to one component systems-water and sulphur, - modified form of phase rule to two component systems. Water–potassium iodide and lead-silver systems. Eutectic mixtures and their applications (examples: freezing mixtures, desilverisation of lead by Pattinson's method).

Chapter 2: Surface Chemistry — 4 hours

Adsorption: Review of types of adsorption and factors affecting adsorption. Freundlich adsorption and Langmuir's adsorption isotherms. Langmuir's isotherm to be derived. BET equation (derivation not required), applications of adsorption.

Catalysis: Characteristics, types of catalysis-homogeneous and heterogeneous catalysis with examples. Mechanisms of catalysis (intermediate compound theory and adsorption theory).

Homogeneous catalysis: Acid–base catalysis, enzyme catalysis.

Heterogeneous catalysis: surface reactions, unimolecular, bi-molecular surface reactions. pH dependence of rate constant of catalysed reactions.

Autocatalysis.

Chapter 3: Analytical Chemistry — 6 hours

Errors-classification, accuracy and precision. Significant figures and computation.

Organic reagents in inorganic analysis- Advantages and uses of:

(i) EDTA in the estimation of calcium (volumetry)
(ii) Oxine in the estimation of magnesium (gravimetry)
(iii) DMG in the estimation of nickel (gravimetry),
(iv) *o*-phenanthroline in the estimation of iron (colorimetry)

Electrogravimetric estimation of copper, flame photometric determination of sodium and potassium.

Chapter 4: Nuclear and Radiochemistry — 8 hours

Nucleus – Structure and stability, binding energy calculations. Instability of the nuclei, radioactive decay law, half-life-Numerical problems. Radioactive equilibrium, radioactive series. Artificial radioactivity – nuclear reactions induced by γ- radiation α, n, p, and d particles. Nuclear fission and fusion. Nuclear reactors, Breeder reactors, atomic energy programme in India. Isotopes - use of radioisotopes in tracer technique, agriculture, medicine, food preservation and carbon dating-Numerical problems.

Chapter 5: Powder Metallurgy **3 hours**

Advantages of powder metallurgy and applications. Methods of production of metal powders. Production of tungsten powder from Wolframite.

Chapter 6: Steel **6 hours**

Iron - carbon phase diagram; Austenite, ferrite, cementite, and pearlite phases.

Alloy steels - influence of Si, Mn, Cr, Ni, Ti and W on the properties of steel.

Ferro alloys –production of ferrochrome, ferromanganese and ferrosilicon and their applications.

Carbon steel – classification. Heat treatment: hardening, casehardening, carbiding nitriding, tempering and annealing.

Chapter 7: Environmental Chemistry **4 hours**

Depletion of ozone in the stratosphere. Causes and remedial measures. The green house effect and its consequences. Acid rain; photochemical smog. Treatment of sewage and industrial effluents. Disposal of radioactive wastes.

Chapter 8: Aldehydes and Ketones **8 hours**

Methods of preparation: Aldehydes from acid chlorides-Rosenmund reaction, Gattermann-Koch reaction. Ketones from nitriles, carboxylic acids with alkyl lithium, acid chlorides with metal alkyls and from esters.

Mechanisms of: aldol condensation, Perkin condensation, Knoevenagel condensation, benzoin condensation and acetal formation. General mechanism of condensation with ammonia and its derivatives (NH_2–R; R = –NH_2, –OH, –NH–CO–NH_2).

Reduction: Mechanisms of Clemmensen and Wolff-Kishner reductions, reduction by $LiAlH_4$ and $NaBH_4$. Mannich reaction.

Chapter 9: Carboxylic acids and their derivatives. **5 hours**

Classification upto ω-carboxylic acids.

Preparation: Hydrolysis of nitriles with mechanism.

Acidic strength-effect of substituents on the strength of aliphatic and aromatic carboxylic acids. Reactions: formation of esters, acid chlorides, amides and anhydrides, Hell-Vollhardt-Zelinski reaction, decarboxylation and reduction.

Di and tri carboxylic acids: Action of heat on dicarboxylic acids, reactions of tartaric acid and citric acid.

Reactions of acid chlorides, acid anhydrides, esters and amides. Mechanism of ester hydrolysis-acid and base catalysed (acyl O-cleavage: $B_{AC}2$, $A_{AC}2$; alkyl O-cleavage $A_{AL}1$ mechanisms).

Chapter 10: Tautomerism and Enolates **4 hours**

Tautomerism in carbonyl compounds: acidity of α-hydrogen atoms, halogenation of enolisable aldehydes and ketones.

Active methylene compounds: Preparation and synthetic applications of diethyl malonate, ethyl acetoacetate and acetyl acetone.

B.Sc. - V Semester
(Organic Chemistry: Paper V)

Contents

Chapter 1: Stereochemistry **8 hours**

Elements of symmetry, chirality, stereogenic centre. Fischer projection formulae.

Enantiomers: Optical activity; use of +/–, *d/l* and D/L notations. Properties of enantiomers, chiral and achiral molecules with two stereogenic centers. Meso compounds. Cohn-Ingold-Prelog sequence rules: R, S system of nomenclature.

Diastereomers: threo and erythro diastereomers.

Racemisation and resolution. Relative and absolute configuration.

Optical isomerism due to restricted rotation about single bonds-diphenyl systems.

Geometric isomerism: Determination of configuration of geometric isomers. Cis & trans, E, Z system of nomenclature. Geometric isomerism in oximes.

Alicyclic compounds: Conformations of four to eight membered cycloalkanes and disubstituted cyclohexanes.

Bicylic systems: Nomenclature and conformations of decalins and norbornane.

Chapter 2 : Amines **5 hours**

Classification. Preparation of alkyl and aryl amines-reductive amination of carbonyl compounds, Gabriel phthalimde synthesis and Hofman bromamide reaction.

Basicity of amines: Inductive, resonance, steric and solvation effects on the basicity of amines. Reaction of amines as nucleophiles. Distinguishing reactions of 1°, 2° and 3° amines. Diazotization and synthetic applications of diazonium salts. Sandmeyer's reaction. (conversion to chlorobenzene, bromobenzene and benzonitrile), hydrolysis, reduction (to phenyl hydrazine and aniline), coupling reactions to give azo dyes (*p*-hydroxyazobenzene and 1-phenylazo-2-naphthol).

Chapter 3 : Heterocyclic compounds **4 hours**

Introduction, classification, structures, resonance and aromatic character of furan, pyrrole, thiophene and pyridine. Methods of preparation and reactions of pyrrole, furan, thiophene, pyridine. Mechanism of electrophilic substitution reactions. Comparison of basicity of pyrrole, pyridine and piperidine. Preparation and reactions of indole, quinoline and isoquinoline.

Chapter 4 : Chemistry of Natural Products **10 hours**

Carbohydrates: Introduction and classification.

Monosaccharides: Aldoses, structures of all the D-aldohexoses. Elucidation of open chain structure of D-glucose. Mechanism of mutarotation and anomeric effect. Elucidation of ring structure of D-glucose in detail.

Ketoses: Fructose, interconversion of glucose and fructose.

Disaccharides: Glycosidic [illegible] structures of maltose, lactose and sucrose-Haworth and conformational structures.

Terpenes and terpenoids: Occurrence, classification and isoprene rule. Elucidation of structure and synthesis of citral and zingiberene. Structures of limonene, menthol, α-terpineol, camphor, β-carotene, Vitamins-A and their uses.

Alkaloids: Introduction, classification and general characteristics. Structural elucidation and synthesis of nicotine. Structures and uses of ephedrine, caffeine, cocaine, atropine, quinine and morphine.

Chapter 5 : Spectroscopy of Organic compounds **8 *hours***

UV-Visible spectroscopy: Introduction. Chromophores and auxochormes; blue shift and red shift. Graphical representation of spectra of 1, 3-butadiene, benzene and lycopene. Influence of conjugation on UV absorption-Comparison of UV spectra of acetone and methyl vinyl ketone.

IR spectroscopy: Introduction. Stretching frequencies of –OH (free and H-bonded), alkyl –C–H, C≡C, C=C, C–C, C=O and C–O groups (by taking suitable examples). Graphical representation of IR spectra of benzoic acid and methyl benzoate.

NMR spectroscopy: Basic principles of proton magnetic resonance: Nuclear magnetic spin quantum number I, influence of the magnetic field on the spin of nuclei, spin population, saturation using radio frequency. Nuclear magnetic resonance. chemical shift (δ values), uses of TMS as reference. Nuclear shielding and deshielding effects. Equivalent and non-equivalent protons. Effect of electronegativity of adjacent atoms on chemical shift values. Spin-spin splitting and spin-spin coupling (qualitative treatment only).

Applications of NMR spectroscopy including identification of simple organic molecules. *Examples*: Shielding and deshielding effects for (i) methane (ii) CH_3–Cl (iii) CH_2Cl_2 (iv) $CHCl_3$. Spin-spin coupling in (i) Cl_2CHCHO (ii) 1,1,2-trichloroethane (iii) CH_3CH_2Cl.

Chapter 6 : Industrial Organic chemistry **5 *hours***

Sythetic dyes: Introduction and classification. Colour and constitution. Synthesis of congo red, malachite green, alizarin and indigo.

Drugs: Chemotherapy, classification of drugs. Synthesis and uses of paracetamol, diclofenac, ranitidine, sulphanilamide and chloramphenicol.

Introduction to Green Chemistry: Principles of Green chemistry and its application to the synthesis of ibuprofen.

B.Sc. - V Semester

(Physical Chemistry: Paper VI)

Contents

Chapter No.	Title	Number of Teaching hours
1	Electrochemistry	15
2	Ionic Equilibria	3
3	Physical properties and Molecular structure	5
4	Chemical Spectroscopy	12
5	Photochemistry	5
	Total	40

Chapter 1: Electrochemistry — 15 hours

Definition of specific conductance, κ, equivalent conductance, Λ and molar conductance, μ in both CGS and SI units. Methods of determination of specific conductance. Evaluation of equivalent and molar conductance. Problems only in SI units. Variation of specific and equivalent/molar conductance with dilution. Strong and weak electrolytes. Conductometric titrations (only acid-base type, no mixture of acids).

Transport numbers: definition – determination by moving boundary method. Causes of abnormal transport numbers observed in certain systems. Problems on transport numbers.

Kohlrausch's law and its applications: (i) evaluation of Λ_∞ from Λ_+ and Λ_- (ii) evaluation of degree of dissociation of a weak electrolyte (iii) evaluation of Λ_∞ of a weak electrolyte (iv) determination of solubility from conductance of saturated solutions of sparingly soluble salts (AgCl and $BaSO_4$). Problems based on these.

Limitations of Arrhenius theory: qualitative account of Debye-Huckel theory, Debye-Huckel-Onsagar equation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation.

Galavanic cell: conventions of representing galvanic cells-reversible and irreversible cells, derivation of Nernst equation for single electrode potential (free energy concept).

Weston-cadmium cell: Determination of emf of a cell by compensation method. Determination of E° of Zn/Zn^{2+} and Cu/Cu^{2+} electrodes. Liquid junction potentials, elimination of liquid junction potential.

Types of electrodes: Metal and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. Reference electrodes-standard hydrogen electrode, calomel electrode, quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Numerical problems.

Concentration cells: (i) emf of concentration cells (ii) determination of solubility of sparingly soluble salts and numerical problems. Redox electrodes, emf of redox electrodes. Potentiometric titration involving only redox systems.

Chapter 2: Ionic equilibria — 3 hours

Hydrolysis of salts of weak acids and weak bases. Ionic product of water. Relationship between K_h, K_w, K_a and K_b. Degree of hydrolysis and its relationship with K_h. Effect of temperature and dilution on degree of hydrolysis. pH of salt solutions. Problems.

Common-ion effect, buffers, buffer action and buffer capacity. pH of buffers. Henderson's equation and its derivation. Solubility product and ionic product in precipitation and in qualitative analysis.

Analytical and biological applications of buffers.

Chapter 3: Physical properties and Molecular structures **5 hours**

Polarization and orientation of dipoles in an electric field. Dipole moment. Induced dipole moment (experimental determination of dipole moment not included). Clausius-Mossotti equation (only statement). Dipole moment and structure of molecules (planar and non-planar).

Magnetic properties-paramagnetic, diamagnetic and ferromagnetic systems. Electrical properties of solids and their applications.

Chapter 4: Chemical Spectroscopy **12 hours**

The interaction of radiation with matter. Regions of electromagnetic spectrum and associated spectroscopic techniques.

Origin of molecular spectra: Born-Oppenheimer approximation.

Rotational spectra of diatomic molecules: Relationship between internuclear distance and moment of inertia. Expression for rotational energy. Numerical problems. Criterion for absorption of radiation-selection rule.

Vibrational spectra: Hooke's law- Expression for the frequency of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero point energy., numerical problems. Degree of freedom of polyatomic molecules–modes of vibration for CO_2 and H_2O molecules.

Raman spectra: Concept of polarisability. Pure rotation, vibration, qualitative study. Stokes and anti-Stoke's lines-selection rules.

Advantages of Raman spectroscopy over IR spectroscopy.

Electronic spectra: Potential energy curves for bonding and antibonding molecular orbitals. Electronic transitions – qualitative description of non-bonding orbitals and transitions between them. Selection rules and Franck-Condon principle.

Chapter 5: Photochemistry **5 hours**

Laws of photochemistry. Grotthus-Draper law, Stark-Einstein law, differences between photophysical and photochemical processes with examples. Comparison of photochemical and thermal reactions. Quantum yield of photochemical combination of (i) H_2 and Cl_2 (ii) H_2 and Br_2 (iii) dissociation of HI (iv) dimerisation of anthracene. Photosensitization, photostationary equilibrium. Singlet and triplet states. Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensors.

Beer-Lambert's law and its applications. Numerical problems on absorption coefficient and molar extinction coefficient.

B.Sc. - VI Semester

(Inorganic Chemistry: Paper VII)

Contents

Chapter 1: Coordination and Organometallic compounds **14 hours**

Coordination compounds, ligands and their classification, coordination number, nomenclature of coordination compounds, detection of complex formation. Theories of structure and bonding – Werner's Theory, EAN rule, Valence bond theory, crystal field theory (octahedral, tetrahedral and square planar complexes). Crystal field splitting and crystal field stabilization energies. Magnetic properties of $[CoF_6]^{3-}$, $[Co(NH_3)_6]^{3+}$, $[Fe(CN)_6]^{4-}$, $[Fe(CN)_6]^{3-}$. Spectral properties of $[Ti(H_2O)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$, $[CoCl_4]^{2-}$. Isomerism-structural and stereoisomerism.

Organometallic compounds – ligands, classification (hapticity); synthesis and structure of a) $K[PtCl_3(\eta^2\text{-}C_2H_4)]$, $[Fe(\eta^5 - C_5H_5)_2]$, b) Metal carbonyls – $Cr(CO)_6$, $Co_2(CO)_8$, $Mn_2(CO)_{10}$; eighteen electron rule and its deviations with examples.

Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Na_2Ca EDTA in the treatment of heavy metals (Pb, Hg) poisoning, Wilkinson's Catalyst in alkene hydrogenation, Monsanto acetic acid process.

Chapter 2: Bioinorganic Chemistry **3 hours**

Essential and trace elements in biological systems, metallo-porphyrins with special reference to haemoglobin, myoglobin and chlorophyll. Role of cyanocobalamin in living systems.

Chapter 3: Industrial Materials **14 hours**

Refractories: Properties, classification, determination of PCE values.

Abrasives – classification, applications, hardness, manufacture and importance of carborundum and tungsten carbide.

Glass: Properties, types, manufacture of soda glass. Borosilicate, metallic glass, optical glasses and polycarbonate glass. Safety glass, fire and bullet proof glasses.

Ceramics: Raw materials, varieties of clay, production of ceramic ware, glazing, insulators.

Cement: Raw materials grades, manufacture of Portland cement (including fly ash as raw material), setting process.

Paints and Varnishes: Constituents of oil and emulsion paints and their role, constituents of varnishes.

Fuels: Characteristics, Calorific value and its determination using bomb calorimeter, Coal-Varieties, Gaseous fuels-advantages, constituents and their significance, production of Coal gas and LPG. Octane number.

Explosives: Classification, preparation of dynamite and TNT

Propellants: Characteristics, classification and their applications.

Chapter 4: Chemistry of Newer materials — 9 hours

Conducting polymers: Definition and examples. Conducting polyanilines, polyacetylenes. Qualitative treatment of doping, electroluminescence.

Properties: elasticity with high electrical conductivities, Engineering and biological applications.

Super conductors: Definition, type 1, type 2 and atypical. Preparation of ceramic super conductors, BCS theory (qualitative treatment only) and applications of super conductors.

Fullerenes: Definition, isolation of C_{60}. Structure and Chemical reactions (redox reactions, electrophilic aromatic substitution and bromination) of C_{60}. Commercial uses of C_{60}. Structure of carbon nanotubes.

Nanomaterials: Introduction. Different methods of production: Sol gel synthesis, inert gas condensation, mechanical alloying, plasma synthesis, electrodeposition and applications.

B.Sc. - VI Semester
(Biochemistry: Paper-VIII)
Contents

Chapter I: Introduction to Biochemistry **2 hours**

Development of biochemistry as a discipline, elemental and biochemical composition of living organisms. Role of water in biochemical systems.

Chapter 2: Carbohydrates **4 hours**

Structure and biological importance of derivatives of monosaccharides–amino sugars, sugar acids, sugar phosphates, N-acetylmuramic acid (NAMA) N-acetylneuraminic acid (NANA).

Structure and biological importance of oligosaccharides – isomaltose, cellobiose, trehalose.

Polysaccharides – source, comparative account of partial structure and biological function of starch, glycogen, cellulose, chitin and inulin.

Chapter 3: Lipids **4 hours**

Structure, nomenclature and biological importance of fatty acids-saturated and unsaturated, triglycerides-simple, mixed and phosphoglycerides, sphingolipids- ceramide.

Definition and significance of saponification number, iodine number and rancidity

Micelles- critical micellar concentration (CMC), formation of mono and bilayers of lipids,

Liposomes-definition and applications.

Clinical significance of lipoproteins and cholesterol.

Chapter 4: Proteins **5 hours**

α - Amino acids: classification on the basis of polarity of R – groups, ionic properties and reaction of amino acids. Essential and non essential amino acids. Peptide bond and its planarity.

Proteins: biological importance, classification based on structure and composition.

Levels of organization of proteins – primary structure, secondary structure (α – helix-triple helix eg. collagen and β – pleated), tertiary structure and forces stabilizing it, quaternary structure.

Denaturation and renaturation-Thermal denaturation-Aufinsen's experiment with ribonuclease.

Chapter 5: Nucleic acids **3 hours**

Types: Components of nucleic acids, bases, nucleosides and nucleotides.

Polynucleotides

Structure of DNA (Watson - Crick model) and RNA. Biological roles of DNA and RNA

Protein-nucleic acid interaction-chromatin and viral nuclear capsid.

Chapter 6: Enzymes **4 hours**

Characteristic features (mention of ribozymes), comparison between biological and non biological catalyst.

Classification (EC Code number not required), active site, specificity, cofactors, Fischer and Koshland models.

Enzyme Kinetics – factors affecting rate of enzymatic reactions.

Allosteric enzymes- definition, example and significance.

Competitive and non competitive inhibition.

Chapter 7: Biological oxidation **3 hours**

Bioenergetics: ATP and other high energy compounds. Energy coupling in biological reactions. Stepwise process of biological oxidation. Mitochondrial electron transport chain, oxidative phosphorylation. Substrate level phosphorylation.

Chapter 8: Metabolism **7 hours**

Catabolism and anabolism: Carbohydrate metabolism, glycolysis, fate of pyruvate. TCA cycle, energetics. Gluconeogenesis.

Fatty acid metabolism – β oxidation pathway, energetics.

Protein metabolism – general aspects of amino acids degradation – deamination, transamination and decarboxylation. Urea cycle.

Chapter 9: Molecular biology **4 hours**

Central dogma of molecular biology. Semi conservative replication and mechanism of replication, transcription, translation.

DNA Fingerprinting, sequencing-Its applications in Human genome mapping.

Chapter 10: Hormones **2 hours**

Hormones: Definition. Classification into a) amino acid derivatives b) peptide and polypeptide hormones c) Steroid hormones with examples and functions.

Role of insulin and glucagon in glucose metabolism.

Mediators of hormone action-Ca^{2+}, cyclic AMP.

Chapter 11: Biochemical techniques **2 hours**

Principle and applications of electrophoresis. Column chromatography, ion exchange, paper and TLC.

Chemistry Practicals for B.Sc. Course

I Semester: Practical 1 (General chemistry) — 3 hours per week

1. Calibration of glass wares: (i) Pipette (ii) Burette (iii) Volumetric flask
2. Estimation of potassium permanganate using standard sodium oxalate solution.
3. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with potassium ferricyanide as an external indicator.
4. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with diphenyl amine as an internal indicator.
5. Estimation of sodium thiosulphate using standard potassium dichromate solution.
6. Estimation of iodine using sodium thiosulphate and standard potassium dichromate solution.
7. Determination of the percentage of available chlorine in the given sample of bleaching powder.
8. Determination of percentage of manganese dioxide from pyrolusite ore.
9. Estimation of chloride by Mohr's method (using potassium chromate as an adsorption indicator).
10. Estimation of chloride by Volhard's method.
11. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.
12. Estimation of nitrogen in an ammonium salt using sodium hydroxide solution and standard oxalic acid.
13. Estimation of carbonate and bicarbonate in a given mixture.

Note: ***Standard solutions to be prepared for experiments 2 to 6.***

II Semester: Practical 2 (Physical chemistry) — 3 hours per week

1. Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.
2. Determination of percentage composition of a binary liquid mixture by viscosity method.
3. Determination of molar mass of polymer by viscosity method.
4. Determination of the density using specific gravity bottle and surface tension of a liquid using Stalagmometer.
5. Determination of molar mass of a non-electrolyte by Walker-Lumsden method.
6. Determination of degree of dissociation of an electrolyte by ebullioscopic method.

7. Determination of distribution coefficient of iodine between water and carbon tetrachloride.
8. Determination of distribution coefficient of acetic acid between water and butanol.
9. Determination of distribution coefficient of benzoic acid between water and toluene.
10. Effect of surfactants on the surface tension of water (Stock solution to be given).

III Semester: Practical 3 (Organic chemistry) — 3 hours per week

Preparation and purification of organic compouds

1. Recrystallisation and determination of melting point of solids (mixed melting point determination and its importance may be mentioned).
2. Simple distillation and determination of boiling point of liquids.
3. Purification of solids by sublimation.

One stage preparation
(Preparation, recrystallisation and melting point determination of the recrystallised sample)

4. Preparation of aspirin from salicylic acid.

   (*Note: Acetic anhydride is to be prepared freshly by distilling acetyl chloride and sodium acetate mixture*).
5. Preparation of paracetamol from *p*-aminophenol.
6. Preparation of dibenzalacetone from benzaldehyde (using acetone-alcoholic sodium hydroxide).
7. Preparation of *p*-aminobenzoic acid from *p*-nitrobenzoic acid.
8. Preparation of *m*-dintrobenzene from nitrobenzene.
9. Preparation of benzoic acid from toluene.

Two stage preparations

10. Preparation of *p*-bromoaniline from acetanilide.
11. Preparation of *p*-nitroaniline from acetanilide.
12. Preparation of *m*-nitrobenzoic acid from methyl benzoate.
13. Preparation of methyl orange/methyl red by diazotization and coupling.

Chromatography

14. **Paper chromatography**: Extraction of spinach (using 1:1 alcohol and Whatmann filter paper)-*To be performed by the students.*
15. **Thin layer chromatography**: Separation of green leaf pigments/separation of a mixture of two organic compounds.
16. **Column chromatography**: Separation of a mixture of two organic compounds.

IV Semester: Practical 4 (Inorganic chemistry) — 3 hours per week

1. Systematic semi-micro qualitative analysis of a mixture of two simple salts (with no interfering radicals).
2. Separation of metal ions (Cu^{2+}, Co^{2+}, Ni^{2+}, Fe^{2+})using paper chromatography and calculation of R_f values (To be performed by the students)
3. Separation of Mg (II) and Fe (II) by solvent extraction technique.
4. Effluent analysis.

V Semester: Practical 5 (Organic chemistry) — 3 hours per week

1. Organic qualitative analysis of mono functional organic compounds through functional group analysis. Determination of physical constant. Preparation and characterization of a suitable derivative.
2. Isolation of lycopene from tomatoes.
3. Isolation of caffeine from tea leaves.

V Semester: Practical 6 (Physical chemistry) — 3 hours per week

1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation.
2. Determination of velocity constant for the saponification of ethyl acetate ($a = b$).
3. The study of kinetics of potassium persulphate and potassium iodide colorimetrically.
4. Determination of equivalent conductivity of 0.1 N sodium chloride and verification of DHO equation.
5. Determination of dissociation constant of monochloroacetic acid by conductivity method.
6. Conductometric titration of hydrochloric acid with sodium hydroxide.
7. Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.
8. Determination of Critical Micellar Concentration (CMC) by conductivity method.
9. Determination of pK_a of a weak acid by pH metric method.
10. To construct the phase diagram of two component system (Ex. diphenyl amine-benzophenone) by cooling curve method.
11. Determination of percentage of sodium chloride by miscibility temperature method.
12. Determination of transition temperature of a salt hydrate by thermometric method.
13. Estimation of Cu^{2+} colorimetrically and verification of Beer-Lambert's law.

VI Semester: Practical 7 (Inorganic chemistry) — 3 hours per week

1. Estimation of percentage of iron in haematite using diphenylamine as an internal indicator.
2. Estimation of calcium in lime stone.
3. Estimation of copper in brass.
4. Estimation of zinc using EDTA.
5. Estimation of total hardness of water using EDTA.
6. Gravimetric estimation of barium as barium sulphate.
7. Gravimetric estimation of nickel as nickel dimethyl glyoximate.
8. Preparation of cuprammonium sulphate and determination of λ_{max} and hence CFSE.
9. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
10. Estimation of nickel using EDTA and standard zinc sulphate.
11. Preparation of ferrous oxalate and its analysis (both iron and oxalate).

VI Semester: Practical 8 (Biochemistry) — 3 hours per week

1. Preparation of buffers and determination of their pH values using pH meter.
2. Estimation of reducing sugars by Hegdorn-Jensen method.
3. Estimation of lactose in milk by Nelson-Somyogi's method.
4. Estimation of creatinine by Jaffe's method.
5. Estimation of inorganic phosphate in food samples by Fiske-Subbarow method.
6. Estimation of total reducing sugars in honey by DNS (dinitrosalicylic acid) method.
7. Isolation of lactose and casein from milk and estimation of lactose by colorimetric method.
8. Estimation of α-amino acids using ninhydrin by colorimetric method.
9. Determination of blood group.
10. Separation of α-amino acids by paper chromatography.
11. Isolation of DNA from onions.
12. Estimation of cholesterol by colorimetric method.

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