B.Sc Chemistry

PREFACE

Department of Chemistry of St Berchmans College, with immense privilege under autonomous status, is presenting the undergraduate syllabus for an effective science education to the students. The curriculum being restructured by giving more importance to different aspects such as creativity, environmental impact due to the development of technology, current development in science and operational skill of various instruments. The academic skills imparted to the students during UG programme make them competent to meet the requirements of a developing country.

The programme is designed by incorporating various units in a systematic and more meaningful manner for the core as well as complementary courses.

The syllabi are prepared to give sound knowledge and understanding of Chemistry to a graduate student and will expose the students to various fields of science. The curriculum is designed after a thorough discussion with academic experts from diverse fields and by considering the existing BSc syllabi of other universities and model curriculum proposed by UGC in order to get continuity in the learning process from the new syllabi of NCERT, which meet the demands of a science aspirant. The number of contact hours as well as list of reference books is mentioned in detail.

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   Vikram Sarabhai Space Centre
   Thiruvananthapuram

8. **Dr. P C Thomas**
   Associate Professor
   Department of Chemistry
   St Berchmans College,
   Changanassery

9. **Dr. K C Philip**
   Associate Professor
   Department of Chemistry
   St Berchmans College,
   Changanassery

10. **Dr. Tomlal Jose E**
    Assistant Professor
    Department of Chemistry
    St Berchmans College,
    Changanassery

11. **Prof. Renjith Thomas**
    Assistant Professor
    Department of Chemistry
    St Berchmans College,
    Changanassery

12. **Dr. Bejoy Francis**
    Assistant Professor
    Department of Chemistry
    St Berchmans College
    Changanassery

13. **Dr. Shijo K Cherian**
    Assistant Professor
    Department of Chemistry
    St Berchmans College
    Changanassery

BSC CHEMISTRY PROGRAMME

Aims and Objectives of the Programme

To equip the students

- to understand the basic facts and concepts in chemistry
- to develop the interest in the study of chemistry
- to appreciate the achievements in chemistry
- to familiarize with the emerging areas in Chemistry
- to develop skills in the proper handling of apparatus, instruments and chemicals
- to familiarize the industrial activities related to chemistry

Course Structure

The **BSc Programme in Chemistry**includes(a) Common courses I & II, (b) Core courses, (c) Complementary Courses, (d) Open Course and (e) Project/Paper Review/Industry Visit Report. No course shall carry more than 4 credits. Open course shall be offered in any subject and the student shall have the option to do courses offered by other departments.

The number of Courses for the Programme should contain 12 core courses, 8 complementary courses, or otherwise specified, from the relevant subjects for complementing the core of study. There should be 10 common courses, or otherwise specified, which includes the first and second language of study.

Open course for other streams

Chemistry department offers Environmental Science during the fifth semester of the programme.

Sl. No.	Course Code	Title of the Course	Exam Duration (hrs)	Credit per Course	Instructional hrs for the course	Instructional hours /week
1.	ECH501	Environmental Science	3	4	54	4

Curriculum for BSc Chemistry Programme

Scheme of distribution of instructional hours for core course

Semester	Theory	Practical
Semester I	2	2
Semester II	2	2
Semester III	3	2

Semester IV	3	2
Semester V	15	10
Semester VI	15	10

Examinations

The evaluation of each course shall contain two parts:

i. Internal or In-Semester Assessment (ISA)

ii. External or End-Semester Assessment (ESA)

Marks of Theory Examination

External examination: 60

Internal evaluation: 10

Components of Internal Evaluation	Marks
Attendance	3
Assignment/Viva	2
Test paper(s) (1 or 2) (1×5=5; 2×2.5=5)	5
Total	**10**

% of Attendance	Marks
90 and above	3
80 - 89	2
75 -79	1

(Decimals are to be rounded to the next higher whole number)

Components of Assignment	Marks
Presentation	0.5
Content	0.5
Reference	0.5
Punctuality	0.5

Components of Seminar	Marks
Presentation	0.5
Content	0.5
Conclusion	0.5

Reference	0.5

Marks of Practical Examination

External examination: 40(only in even semesters)

Internal evaluation: 20(odd and even semesters combined annually)

Components of Internal Evaluation	Marks
Attendance	4
Record*	6
Laboratory involvement	4
Test (one)	2
Viva Voce	4
Total	**20**

*****Marks awarded for Record should be related to the number of experiments recorded

% of Attendance	Marks
90 and above	4
85--89	3
80--84	2
75--79	1

(Decimals are to be rounded to the next higher whole number)

Laboratory Involvement	Marks
Punctuality	1
Handing Equipment	1
Skill in Laboratory Work	1
Group Interaction	1

Project/Paper Review/Industry Visit Evaluation

All students are to do a Project/Paper Review/Industry Visit Report. The project can be done individually or as a group of three students. The projects are to be identified during the fifth semester of the programme with the help of the supervising teacher. The report of the project in duplicate is to be submitted to the department at the sixth semester and are to be produced before the examiners appointed by the College. The Paper Review shall be done in the fifth semester

and the review in duplicate is to be submitted to the department at the sixth semester and are to be produced before the examiners appointed by the College. The Industry Visit shall be done during fifth or sixth semester of the programme and a report in duplicate shall be submitted to the department at the sixth semester and are to be produced before the examiners appointed by the College.

Maximum marks: 100

Components of Evaluation	Marks
Internal Evaluation of Report	20
Dissertation (External)	50
Viva-Voce (External)	30
Total	**100**

Components of Report	Marks
Introduction	5
Content	10
Presentation	5

Seminar

A subject based seminar should be presented by the student during the programme. The student should present the seminar using power point and

Components of Evaluation	Marks
Content	50
Presentation	20
Interaction	30
Total	**100**

Internal Assessment Test Papers

At least one internal test paper is to be attended in each semester for each course. The evaluations of all components are to be published and are to be acknowledged by the students. All documents of internal assessments are to be kept in the department for two years and shall be made available for verification by the College. The responsibility of evaluating the internal assessment is vested on the teacher(s), who teach the course.

Pattern of questions for external examination for theory papers

Sl. No.	Type of Questions	Number of Questions to be answered	Marks	Total Marks
1	Very short answer type	8 (no choice)	1	8
2	Short answer type	6 out of 10	2	12
3	Short essay/problem solving type	4 out of 6	4	16
4	Essay type	2 out of 4	12	24
				60

Course Structure

Total Credits : 120 Total instructional hours : 150

BSc Programme in Chemistry (Core courses)

The following table shows the structure of the programme which indicate course code, title of the courses, instructional hours,credits, examination time and the components for internal and external evaluation

Detailed Scheme of Instruction of the Core Course

Sl. No.	Course Code	Title of the Course	Exam Duration (hrs)	Credit per Course	Instructional hrs for course	Instructional hours /week
Semester I						
1	BCH101	Theoretical Chemistry - I	3	2	36	2
2		Practical: Qualitative Inorganic Analysis	-	-	36	2
Semester II						
3	BCH202	Physical Chemistry- I	3	2	36	2
4	BCH2P01	Practical: Qualitative Inorganic Analysis	3	2	36	2
Semester III						
5	BCH303	Organic Chemistry - I	3	3	54	3
6		Practical: Qualitative Organic Analysis	-	-	36	2
Semester IV						

7	BCH404	Inorganic chemistry- II	3	3	54	3
8	BCH4P02	Practical: Qualitative Organic Analysis	3	2	36	2
Semester V						
9	BCH505	Inorganic Chemistry-III	3	3	54	3
10	BCH506	Organic Chemistry-II	3	3	54	3
11	BCH507	Organic Chemistry-III	3	3	54	3
12	BCH508	Physical Chemistry-II	3	2	36	2
13		Open Corse	3	4	72	4
14		Practical: Organic Chemistry Practical - II	-	-	54	3
15		Practical: Physical Chemistry Practical	-	-	36	2
16		Practical: Gravimetric Analysis	-	-	54	3
17		Practical: Volumetric Analysis	-	-	36	2
Semester VI						
18	BCH609	Inorganic Chemistry-IV	3	3	54	3
19	BCH610	Organic Chemistry-IV	3	3	54	3
20	BCH611	Theoretical Chemistry- II	3	3	54	3
21	BCH612	Physical Chemistry - III	3	3	54	3
22	BCH613	Environmental Chemistry	3	3	54	3
23	BCH6P03	Practical: Organic Chemistry Practical - II	3	2	54	3
24	BCH6P04	Practical: Physical Chemistry Practical	3	2	36	2
25	BCH6P05	Practical: Gravimetric Analysis	3	2	54	3
26	BCH6P06	Practical: Volumetric Analysis	3	2	36	2
27	BCH6D1	Project/Paper Review/Industry Visit Report	-	1	-	-
28		Seminar	-	1	-	-

SEMESTER I

Sl. No.	Course Title	hrs/ week	Credit
CEN101	Common Course: English - I	5	4
CEN102	Common Course: English - II	4	3
	Common Course: Second Language - I	4	4
BCH101	Core Course: Theoretical Chemistry - I	2	2
	Core Course Practical: Qualitative Inorganic Analysis	2	-
DPC101	Complementary Course I: Physics	2	2
DPC1P01	Complementary Course Practical: Physics	2	-
DMM101	Complementary Course II: Mathematics	4	3
	Total	**25**	**18**

SEMESTER II

Sl. No.	Course Title	hrs/ week	Credit
CEN203	Common Course: English - III	5	4
CEN204	Common Course: English - IV	4	3
	Common Course: Second Language - II	4	4
BCH202	Core Course: Physical Chemistry - I	2	2
BCH2P01	Core Course Practical: Qualitative Inorganic Analysis	2	2
DPC202	Complementary Course I: Physics	2	2
DPC2P02	Complementary Course Practical: Physics	2	2
DMM202	Complementary Course II: Mathematics	4	3
	Total	**25**	**22**

SEMESTER III

Sl. No.	Course Title	hrs/ week	Credit
CEN305	Common Course: English - V	5	4
CEN306	Common Course: Second Language - III	5	4
BCH303	Core Course: Organic Chemistry- I	3	3
	Core Course Practical: Qualitative Organic Analysis	2	-
DPC303	Complementary Course I: Physics	3	3
DPC3P03	Complementary Course Practical: Physics	2	-
DMM303	Complementary Course II: Mathematics	5	4
	Total	**25**	**18**

SEMESTER IV

Sl. No.	Course Title	hrs/ week	Credit
CEN407	Common Course: English - VI	5	4
CEN408	Common Course: Second Language - IV	5	4
BCH404	Core Course: Inorganic Chemistry - II	3	3
BCH4P02	Core Course Practical: Qualitative Organic Analysis	2	2
DPM404	Complementary Course I: Physics	3	3
DPM4P04	Complementary Course Practical: Physics	2	2
DMM404	Complementary Course II: Mathematics	5	4
	Total	**25**	**22**

SEMESTER V

Sl. No.	Course Title	hrs/ week	Credit
BCH505	Core Course: Inorganic Chemistry-III	3	3
BCH506	Core Course: Organic Chemistry-II	3	3
BCH507	Core Course: Organic Chemistry-III	3	3
BCH508	Core Course: Physical Chemistry-II	2	2
OCH501	Open Corse	4	4
	Core Course Practical: Organic Chemistry Practical - II	3	-
	Core Course Practical: Physical Chemistry Practical	2	
	Core Course Practical: Gravimetric Analysis	3	
	Core Course Practical: Volumetric Analysis	2	
	Total	**25**	**15**

SEMESTER VI

Sl. No.	Course Title	hrs/ week	Credit
BCH609	Core Course:Inorganic Chemistry-IV	3	3
BCH610	Core Course:Organic Chemistry-IV	3	3
BCH611	Core Course:Theoretical Chemistry- II	3	3
BCH612	Core Course:Physical Chemistry-III	3	3
BCH613	Core Course: Environmental Chemistry	3	3
BCH6P03	Core Course Practical: Organic Chemistry Practical - II	3	2
BCH6P04	Core Course Practical: Physical Chemistry Practical	2	2
BCH6P05	Core Course Practical: Gravimetric Analysis	3	2
BCH6P06	Core Course Practical: Volumetric Analysis	2	2
BCH6PJ	Project/Paper Review/Industry Visit Report	-	1
BCH6SR	Seminar (Power point presentation, minimum 30 mins, internal evaluation)	-	1
	Total	25	25

SEMESTER I
THEORETICAL CHEMISTRY- I

Credits: 2 36hrs

Unit I: Basic Quantum Chemistry and Atomic Structure (18 hrs)

Bohr atom model (derivation), explanation of spectrum of hydrogen and hydrogen like systems,limitations of Bohr theory, Sommerfield's extension to Bohr theory.

Dual Nature of electron- evidences for particle and wave nature- photoelectric effect, Davisson and Germer experiment, Heisenberg Uncertainty Principle, Compton Effect, Planck's Quantum theory of radiation.

Wave Mechanics- Schrodinger's equation (justification required),time dependent Schrodinger's equation (justification not needed),operators in quantum mechanics. Postulates of quantum mechanics, orthogonality and normalization, Hermetian operators, Hamiltonian operator, operator formalism of Schrodinger's equation, Born interpretation of the wave function, particle in one dimensional box (derivation expected).

One dimensional harmonic oscillator and rigid rotor (qualitative idea only, detailed derivations not expected), Hydrogen atom,radial and angular probability distribution curves.Shapes of s, p and d orbitals,shape of f orbitals (basic idea).

Quantum numbers- principal, azimuthal, magnetic, and spin, Stern Gerlac quantum numbers- principal, azimuthal, magnetic, and spin, Stern Gerlac experiment.

References

1. P.W. Atkins, Physical Chemistry, 4th& 5th Edns., 1993
2. P. W. Atkins and J. de Paula, Atkin's Physical Chemistry, 7th Edn., Oxford University Press, 2006
3. D.A. McQuarrie and J.D. Simon, Physical Chemistry - A Molecular Approach, Viva Books Pvt. Ltd. 2004
4. Ira N. Levine, Physical Chemistry, 6th Edn., Mc Graw Hill, 2009
5. Ira N. Levine, Quantum Chemistry, 7th Edn., Prentice Hall, 2013
6. R. K. Prasad, Quantum Chemistry, Wiley Eastern Ltd., 2006

Unit II: Chemical Bonding (9 hrs)

Ionic bond – Lattice energy of ionic compounds - Born-Lande equation (derivation not expected), Born-Haber cycle and its applications, lattice energy, solubility, polarisation of ions – Fajan's rules.

Covalent bond -polarity of covalent bond, percentage of ionic character, dipole moment and molecular structure, co-ordinate bond, VSEPR theory, hybridisation – sp, sp^2, sp^3, sp^3d and sp^3d^2 hybridisations, structure of H_2O, NH_3, XeF_2, XeF_4, SF_4, ClF_3, IF_7, I_3^-,SO_4^{2-}Valence bond theory (VB) and its limitations, VB of hydrogen atom (no derivation).Molecular orbital theory (MOT), linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals.Applications ofMO theory to explain the stability of homo and heterodiatomic molecules (N_2, O_2, CO and NO), bond strength and bond energy.

Metallic Bond - Free electron, valence bond and band theories (basic ideas only, derivations not expected).

Unit III: Periodic Classification (9 hrs)

Modern periodic law -Long form of periodic table, periodicity in properties -atomic, ionic, covalent radii (octahedral and tetrahedral), ionization enthalpy, successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy, electron affinity, electronegativity.Paulings, Mulliken and Allred Rochow's scales of electronegativity.Variation of electronegativity with bond order, partial charge, hybridisation and group electronegativity.Effective nuclear change – screening effect – Slater rules.

Reference

1. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity,4th Edn., Pearson Education, 2006
2. J. D. Lee, Concise Inorganic Chemistry, 5th Edn., Chapman & Hall, 2002
3. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd Edn., Oxford University Press, New Delhi, 2004
4. F.A. Cotton. and G. Wilkinson, Advanced Inorganic Chemistry, 1st-6th Edns., Wiley Interscience, 1962, 1966, 1972, 1980, 1988, 1999
5. Manas Chanda,Atomic Structure and Chemical Bonding, Tata Mc Graw Hill, 2007
6. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers and Distributors, 2008
7. R.Gopal, Inorganic Chemistry for Undergraduates, UniversitiesPress, India Pvt.Ltd., 2009
8. P.L.Soni, Text book of Inorganic Chemistry, S. Chand and Sons, 2007

SEMESTER 2
PHYSICAL CHEMISTRY - I

Credits: 2 36 hrs

Unit I: Gaseous State and Liquid State (18 hrs)

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor*Z*, and its variation with pressure for different gases. Causes of deviation from ideal behaviour,van der Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrich); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity,explanation of cleansing action of detergents.Temperature variation of viscosity of liquids and comparison with that of gases.Qualitative discussion of structure of water.

Unit II: Kinetics and Photochemistry (18 hrs)

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Determination of order of reactions.

Temperature dependence of reaction rates: Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Photochemistry: Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence, Jablonski diagram.

Reference

1. B. R. Puri, L. R Sharma and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company, Jalandhar, 2010
2. K.L. Kapoor, Physical Chemistry, Vol. I, II, III & IV, Mac Millan (India) Ltd., 2000

3. P. Atkins and J. de Paula, Atkin's Physical Chemistry, 7th Edn., Oxford University Press, 2006
4. F. A. Alberty and R. J. Silby, Physical Chemistry, 3 rd Edn., John Wiley & Sons, 2004
5. J. Rajaram and J. C. Kuriakose, Thermodynamics, Shoban Lal Nagin Chand & Co.,1986
6. G. K. Vemulapalli, Physical Chemistry, PrenticeHall of India Pvt. Ltd.,1997

SEMESTER -III
ORGANIC CHEMISTRY- I

Credits: 3 54hrs

Unit I: Electronic Effects, Mechanism, Stereochemistry and Conformational Analysis (18 hrs)

Electronic displacements: Inductive, electromeric and mesomeric effects,resonance, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and nucleophiles; nucleophlicity and basicity.

Reaction intermediates: Types, hybridization, shape and their relative stability of carbocations, carbanions, free radicals, carbenes, nitrenes, benzynes.

Stereoisomerism: Fischer projection, Newmann and Sawhorse projection formulae and their interconversions; geometrical isomerism: cis - trans and syn-anti isomerism E/Z notations with C.I.P rules.

Optical Isomerism: optical activity, specific rotation, chirality/asymmetry, enantiomers, molecules with two or more chiral-centres, diastereoisomers, meso structures, racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations. Asymmetric synthesis: Asymmetric induction (basic idea only).

Stereoisomerism of alicyclic compounds:conformations of ethane, propane, butane, cycloalkanes, Bayers strain theory. Different conformers of cyclohexane and monosubstituted cycloalkanes.

Unit II: Aromatic compounds and aromaticity (18hrs)

Concept of resonance: resonance energy,heat of hydrogenation and heat of combustion of benzene, mention of C-C bond lengths and orbital picture of benzene. Structure of naphthalene and anthracene (molecular orbital diagram and resonance energy).

Concept of aromaticity: aromaticity (definition), Huckel's rule: application to benzenoid; benzene, naphthalene and non – benzenoid compounds;cyclopropenyl cation, cyclopentadienyl anion and tropylium cation. Antiaromaticity,homoaromaticity, NMR evidence of aromaticity.

Benzene: structure, electrophilic substitution reactions with mechanism: halogenation, nitration, sulphonation, Friedel-Craft's alkylation and acylation.

Reactivity and orientation of arenes: synthesis, substitution reactions, side chain and ring halogenation and side chain oxidation. Structure and stability of benzyl cation.Alkenyl and alkynylbenzenes: nomenclature, synthesis and reactions.

Reactions: General mechanism of electrophilic substitution, mechanism of halogenation, nitration, Friedel Craft's alkylation and acylation. Orientation of aromatic substitution:definition of *ortho, para* and *meta*directing groups. Ring activating and deactivating groups with examples. Orientation of (i).amino, methoxy and methyl groups (ii). carboxy, nitro, nitrile, carbonyl and sulfonic acid groups. (iii). halogens(explanation by taking minimum of one example from each type is required).

Polynuclear aromatic hydrocarbons: Preparation and reactions of naphthalene, anthracene, phenanthrene, naphthol and naphthyl amine. Reactivity of naphthalene towards electrophilic substitution,nitration and sulphonation.

Aromatic nucleophilic substitutions: bimolecular displacement mechanism, elimination – addition mechanism. Reactivity and orientation in aromatic nucleophilic substitutions.

Unit III: Aliphatic hydrocarbons (18 hrs)

Alkanes: preparation of alkanes - Wurtz reaction, reduction or hydrogenation of alkenes, Corey- House method.Reactions: mechanism of halogenation, free radical substitution, sulphonation, nitration, oxidation, cracking and aromatisation.

Cycloalkanes: preparation using Wurtz reaction, Dieckmann's ring closure and reduction of aromatic hydrocarbons.Reactions: mechanism of substitution and ring opening reactions.

Alkenes: general methods of preparation, dehydrogenation, preparation by elimination, dehydrohalogenation, dehydration, Hoffmann and Saytzeff rules, cis and trans eliminations.E1, E2, E1CB, Saytzeff and Hoffmann elimination.Elimination versus substitution. Addition reactions: electrophilic, Markonikov's rule, peroxide effect, additions involving carbocation rearrangement, nucleophilic, free radical additions, Wagner – Meervin rearrangement, oxy mercuration - demercuration, hydroboration, ozonolysis, cis and trans additions with examples.

Dienes: stability of dienes (conjugated, isolated and cumulative dienes). General methods of preparation, mechanism of dehydrohalogenation. reaction: mechanism of 1,2- and 1,4-additions, Diels-Alder reactions. Polymerization: addition polymerization, Ziegler Natta catalysed polymerization (basic idea only).

Self Study:-Organic compounds: classification, and nomenclature, hybridization, shapes of molecules, influence of hybridization on bond properties. Petroleum refining.

References

1. I.L. Finar, Organic Chemistry, Vols. 1 & 2, 5th Edn., Pearson Education, 2005
2. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, 2nd Edn., Ane Books India, 2013
3. P. Sykes, A Guide to Mechanism in Organic Chemistry, 6th Edn., Pearson Education, 2004
4. P. S. Kalsi, Organic Reactions and Their Mechanisms, 8th Edn.,New Age International, 2014
5. J. March, Advanced Organic Chemistry, 6th Edn., John Wiley & Sons, 2007
6. J. Clayden, N. Greeves,S. Warren,Organic Chemistry, 7th Edn., Oxford University Press, 2012
7. R. T. Morrison and R. N. Boyd, Organic Chemistry, 6th Edn.,Prentice–Hall, 2004
8. K.S. Tewari and N.K. Vishnoi, Organic Chemistry, 3rd Edn., VikasPublishing House
9. M. K. Jain and S.C. Sharma, Modern Organic Chemistry, 3rd Edn., VishalPublishing Company
10. S. M. Mukherji and S.P. Singh, Reaction Mechanism in Organic Chemistry,Macmillan, 1984

SEMESTER IV
INORGANIC CHEMISTRY - II

Credits: 3 54 hrs

Unit I: Characteristic and Distinctive Properties of s, p, d and f Block Elements (18 hrs)

Chemistry of s -block elements: inert pair effect, relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation.

Hydrogen:hydrides - classification and chemistry. Heavy water: manufacture and properties.

Alkali metals: Li, Na, K, Rb and Cs - occurrence, comparative study of elements, oxides, halides, hydroxides and carbonates. Exceptional property of lithium.

Alkaline earth metals: Be, Mg, Ca, Sr and Ba - occurrence and comparative study of the elements, oxides, hydroxides, halides, sulphates and carbonates. Hydrides and their classification: ionic, covalent and interstitial. Basic beryllium acetate and nitrate.Exceptional property of Beryllium.

p -Block elements: comparative study of the p-block elements- groups 13- 18 with special reference to electronic configuration, structure of elements and trends in atomic and ionic radii, ionization potential, electron affinity, electronegativity and oxidation states,inert pair effect.

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses;boric acid and borates, boron nitrides, borohydrides (diborane), borazene, carboranes, silanes, oxides and oxoacids of nitrogen, phosphorus and chlorine.Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

Unit II: Nuclear Chemistry (12 hrs)

The nucleus: subatomic particles, structure of the nucleus-shell model, liquid drop model (basic idea); forces in the nucleus, mesons; stability of nucleus-n/p ratio, binding energy; radioactive elements. Mass defect: energy produced during common nuclear reactions. Radiochemistry: natural and induced radioactivity; radioactive decay α-decay, β-decay, γ-decay, neutron emission, positron emission, electron capture, unit of radioactivity (Curie); half-life period; Geiger-Nuttal rule, radioactive displacement law, radioactive series. Nuclear reactions: types of nuclear reactions, spallation, nuclear fission-theory of nuclear fission; chain reaction, critical mass; nuclear reactors-fast breeder reactors, fuels used in nuclear reactors, separation of isotopes, moderators, coolants; nuclear fusion. Atom bomb, neutron bomb and hydrogen bomb (principles).

Applications: energy tapping, radio carbon dating, neutron activation analysis, isotopic labelling studies, nuclear medicine.

Unit III:Noble Gases (6 hrs)

Occurrence and uses, rationalization of inertness of noble gases,clathrates, preparation and properties of XeF_2, XeF_4, and XeF_6; nature of bonding in noble gas compounds (valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds – fluorides and oxy fluorides. (VSEPR theory).Separation of noble gases and uses.

Unit II: Analytical Chemistry and Environment Chemistry (18hrs)

Evaluation of analytical data: sampling, evaluation of analytical data, significant figures, errors, accuracy and precision, methods of their expression, normal law of distribution, determinate and indeterminate errors, statistical test of data; f, Q, and t test, rejection of data, and confidence intervals.

Solvent extraction: classification and principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media.

Chromatography: Classification and principle and efficiency of the technique. Mechanism of separation: adsorption, partition and ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Environmental chemistry:basic principles, concepts and scope of environmental planning. Conservation of energy:renewable and non-renewable energy sources-nuclear energy, solar energy, hydrogen, non-conventional energy sources.

Environmental pollution: air pollution, water pollution, radioactive pollution, noise pollution- main causes and effects. Greenhouse effect, ozone layer depletion, photochemical and London smog, Minamata disease, Bhopal gas tragedy, acid rain, eutrophication, biological magnification.

Reference

1. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity,4th Edn. Pearson Education, 2006
2. J. D. Lee, Concise Inorganic Chemistry, 5th Edn, Chapman & Hall, 2002
3. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd Edn., Oxford University Press, New Delhi, 2004
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5. F.A. Cotton. and G. Wilkinson, Advanced Inorganic Chemistry, 1st-6th Edns., Wiley Interscience, 1962, 1966, 1972, 1980, 1988, 1999
6. D. A. Skoog, F. James Holler, Stanley R. Crouch, Principles of Instrumental Analysis, 6thEdition, Thomson Asia Pvt. Ltd., London, 2006
7. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers and Distributors, 2008
8. R.Gopal, Inorganic Chemistry for Undergraduates, Universities press, India Pvt.Ltd., 2009.
9. P.L.Soni, Text Book of Inorganic Chemistry, S.Chand and Sons, 2007
10. Gary D Christian; Analytical Chemistry, 6thEdn. New York, John Wiley, 2004

SEMESTER V
INORGANIC CHEMISTRY - III

Credits: 3 54 hrs

Unit I: d and f Block Elements (18hrs)

Transition Metals: general group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer andPourbaix diagrams).Difference between first, second and third transition series.

Chemistry of Ti, V, Cr, Mn, Fe and Co in various oxidation states (extractive metallurgy not expected)

Lanthanides andactinides: comparative study of lanthanide elements with respect to electronic configuration, atomic and ionic radii, oxidation state and complex formation, colour, spectral and magnetic properties. Lanthanide contraction.Occurrence and principles of separation of lanthanides.

General features and chemistry of actinides. Trans-uranium elements. Genesis of elements and extension of periodic table.Szilard-Chalmers' separation process.processing of spent fuel, extraction of U^{233} and Pu^{239}.

Unit II: Coordination Chemistry (6 hrs)

Werner's theory, electronic interpretation of co-ordination compounds, EAN rule, types of ligands, nomenclature, isomerism, stability of complexes, factors influencing stability, application of coordination compounds in qualitative and quantitative analysis.

Unit III: Theories of Bonding in Coordination Compounds (18 hrs)

VBT, CFT and MOT, merits and demerits, CFT – crystal field splitting in tetrahedral,square planarand octahedral complexes,factors affecting crystal field splitting, CFSE of complexes, consequences of crystal field splitting, tetragonal distortions from octahedral geometry. Jahn-Teller.Qualitative aspect of ligand field and MO theory.Spectrochemical series.Explanation of geometry, magnetism and colour on the basis of the above theories. Origin of colour in coordination complexes, d-d transition, charge transfer transition (MLCT, LMCT).Reactivity of metal complexes: labile and inert complexes, ligand substitution reactions, substitution reactions of square planar complexes – transeffect.

Unit IV:Organometallic Compounds (9 hrs)

Definition, classification based on the nature of metal-carbon bond. 18 electron rule, hapticity.Metal carbonyls: mononuclear and polynuclear carbonyls (give examples of Fe, Co, Ni) bonding in metal carbonyls,preparation of carbonyls of Fe and Ni. Ferrocene: preparation, properties, structure and bonding (only qualitative treatment). Applications of organometallic compounds: Ziegler-Natta catalyst, Wilkinson catalyst (mechanism not expected).

Unit V: Non-aqueous solvents (3 hrs)

Non-aqueous solvents: physical properties of a solvent for functioning as an effective reaction medium. Types of solvents and their general characteristics.Reactions in liquid ammonia and liquid sulphur dioxide.

References

1. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edn. Pearson Education, 2006
2. J. D. Lee, Concise Inorganic Chemistry, 5th Edn, Chapman & Hall, 2002
3. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd Edn., Oxford University Press, New Delhi, 2004
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5. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers and Distributors, 2008
6. R. Gopal, Inorganic Chemistry for Undergraduates, Universities press, India Pvt. Ltd., 2009
7. P. L. Soni, Text Book of Inorganic Chemistry, S. Chand and Sons, 2007
8. Gary D Christian; Analytical Chemistry, 6th Edn. New York, John Wiley, 2004
9. S. M. Khopkar, Basic Concepts of Analytical Chemistry, New Age, International Publisher, 2009
10. R.Gopalan and V. Ramalingam, Concise Coordination Chemistry, Vikas Publishing House, New Delhi
11. H. J. Emeleus and A. G. Sharpe, Modern Aspects of Inorganic Chemistry, UBS Publishers Distributors Ltd., 2000

SEMESTER V
ORGANIC CHEMISTRY - II

Credits: 3 54 hrs

Unit I: Alkynes,Alkyl Halides and Polyhalogen Compounds (18 hrs)

Alkynes: preparation, mechanism of dehydrohalogenation and dehydrogenation. Reactions: acidity of alkynes, formation of acetylides, mechanism of addition of water, hydrogen halides and halogens, oxidation, ozonolysis and hydroboration/oxidation.

Alkyl halides: nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides,S_N2 and $S_N1$with energy profile diagrams. Effect of solvent, substrate, nucleophile, nucleofuge, neighbouring group participation. S_Ni mechanism with examples.

Methods of formation of aryl halides,nuclear and side chain reactions. The addition-elimination and the elimination - addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides vs. allyl, vinyl and aryl halides.Synthesis and uses of DDT and BHC.Polyhalogen compounds: chloroform and carbon tetrachloride- preparation, reactions and uses.

Grignard reagents: preparation, structure and synthetic applications,alkyl lithium compounds.

Unit II: Alcohols, Phenols and Ethers (9 hrs)

Aliphatic alcohols: preparation by hydroboration, oxidation, reduction of carbonyl compounds, epoxidation, fermentation of carbohydrates and Grignard synthesis. Reactions with reference to C-OH bond cleavage and O-H bond cleavage, iodoform test.Ascent and descent in alcohol series. Dihydric and trihydric alcohols: reactions with lead tetra acetate and periodic acid. Pinacol- pinacolone rearrangement.Alcoholic beverages.

Phenols: nomenclature, physical properties, hydrogen bonding. Preparation: Industrial source, preparation from diazonium salts and sulphonic acids. Reactions: acidity, ether formation, ester formation, mechanism of ring substitution, nitration, sulphonation, halogenation, Friedel Craft's reaction, nitrosation, coupling reactions, Kolbe's reaction and Riemer-Tiemann reaction.Lederer -Manase reaction, Fries rearrangement.Preparation and uses of nitrophenols, picric acid, catechol, resorcinol, quinol and naphthols.

Ethers and epoxides: nomenclature and classification. Preparation by Williamson's synthesis and alkoxy mercuration-demercuration methods. Reactions: cleavage by acids. Preparation and reactions of epoxides.Preparation and reactions of thiols and thioethers.

Unit III- Aldehydes and Ketones (9 hrs)

Aldehydes and ketones: nomenclature and classification.Preparation of aldehydes and ketones.Reactivity of carbonyl groups, acidity of alpha hydrogen.

Reactions: mechanism of enolization reactions, nucleophilic addition, oxidation and reduction reactions, addition reactions with Grignard reagents, cyanide, and bisulphate, preparation of derivatives of ammonia and alcohols.

Mechnism of aldol, Perkin, Knoevenagel reactions and benzoin condensation, Claisen, Wittig, Cannizarro, Beckmann, benzyl -benzilic acid rearrangement and Reformatsky reactions.Mechanism of reductions with $NaBH_4$, $LiAlH_4$,

Active methylene compounds: keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Unit IV: Heterocyclic Compounds and Natural Products (18 hrs)

Classification: five membered ring compounds: Preparation of furan, pyrrole and thiophene. Reactions: electrophilic and nucleophilic substitutions, oxidation and reduction reactions. Six membered rings: synthesis of pyridine, piperidine,quinoline and isoquinoline: Preparation by ring closing reactions. Reactions: mechanism of electrophilic and nucleophilic substitutions, oxidation and reduction reactions.Basicity of heterocyclic compounds in comparison with amines.Synthesis of indole (Skraup's method, Bishler - Napieralski and Fischer-Indole synthesis).

Alkaloids: definition, occurrence, extraction of alkaloids from plants, general properties. Structural elucidation of coniine, piperine and nicotine.

Terpenoids: classification, isoprene rule, isolation and general properties.Occurrence, general structure and physical properties of geraniol, citral, menthol, α-pinene and camphor.Structural elucidation of citral and geraniol.

References

1. I. L. Finar, Organic Chemistry, Vols. 1 & 2, 5th Edn., Pearson Education, 2005
2. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, 2nd Edn., Ane Books India, 2013
3. P. Sykes, A guide to mechanism in Organic Chemistry, 6th Edn., Pearson Education, 2004
4. P. S. Kalsi, Organic Reactions and Their Mechanisms, 8th Edn.,New Age International, 2014
5. J. March, Advanced Organic Chemistry, 6th Edn., John Wiley & Sons, 2007
6. J. Clayden, N. Greeves,S. Warren,Organic Chemistry, 7th Edn., Oxford University Press, 2012
7. R. T. Morrison and R. N. Boyd, Organic Chemistry, 6th Edn.,Prentice–Hall, 2004
8. K. S. Tewari and N.K. Vishnoi, Organic Chemistry, 3rd Edn., Vikas Publishing House
9. M. K. Jain and S. C. Sharma, Modern Organic Chemistry, 3rd Edn., Vishal Publishing Company
10. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Macmillan, 1984
11. B. S. Bahl and Arun Bahl 'Advanced organic Chemistry', S. Chand

SEMESTER V
-ORGANIC CHEMISTRY - III

Credits: 3 54 hrs

Unit I: Carboxylic Acids and Derivatives (18 hrs)

Nomenclature and classification of aliphatic and aromatic carboxylic acids.,preparationand reactions. Acidity (effect of substituents on acidity) and salt formation.Ascent and descent in the homologous series.

Reactions: Mechanism of reduction, substitution in alkyl or aryl group. Preparation and properties of dicarboxylic acids such as oxalic, malonic, succinic, glutaric, adipic and phthalic acids and unsaturated carboxylic acids such as acrylic, crotonic and cinnamic acids.Reactions: Action of heat on hydroxy and amino acids, and saturated dicarboxylic acids, stereospecific addition to maleic and fumaric acids. HVZ reaction, Coumarins.

Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification.Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation.

Benzene sulphonic acids: preparation, reactions and uses. Benzene sulphonyl chlorides: o and p toluene benzene sulphonyl chlorides- uses.

Unit II: Nitrogen compounds (18 hrs)

Preparation and important reactions of nitro and compounds, nitriles and isonitriles.Preparation of nitroalkanes and nitroarenes.Chemical reactions of nitroalkanes.Mechanism of nucleophilic substitution in nitro arenes and their reduction in acidic, neutral and alkaline media. Picric acid and formation of charge transfer complexes.

Diazomethane and diazoacetic ester: Preparation, structure and synthetic applications. Arndt- Eisterdt synthesis and Wolf rearrangement (mechanism).

Amines: Effect of substituent and solvent on basicity,preparation and properties: Gabriel phthalimide synthesis, carbylamine reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction, Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. Diazonium Salts: preparation and their synthetic applications- Sandmayer, Gatterman and Gomberg reactions (with mechanism).

Amino acids, Peptides and their classification: α-Amino Acids - Synthesis- phthalimide synthesis, Strecker synthesis, solution phase peptide synthesis. Zwitterions, pKa values, isoelectric point and electrophoresis. Structure of proteins:primary, secondary and tertiary structures of proteins: α-helix and β- pleated sheets, denaturation of proteins.

Components of nucleic acids, nucleosides and nucleotides. Structure, synthesis and reactions of: adenine, guanine, cytosine, uracil and thymine.Structure of polynucleotides-Watson and Crick model of DNA, structure of RNA.

Urea and thiourea: preparation and reactions. Semicarbazide and basicity of guanines.

Unit III: Carbohydrates and Some Biologically Important Compounds (18 hrs)

Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures,interconversions of aldoses and ketoses; Kiliani-Fischer synthesis and Ruff degradation (ascent and descent in number of C atoms).Disaccharides: reactions, structure of sucrose and maltose,ring structure. Polysaccharides: starch and cellulose:elementary idea only. Applications of starch and cellulose.

Introduction to oils and fats; common fatty acids present in oils and fats, hydrogenation of fats and oils, saponification value, acid value, iodine number. Reversion and rancidity.

Enzymes: Classification, mechanism of enzyme action, enzyme inhibition. Uses of common enzymes.Enzyme inhibitors.

Steroids: structure and function of cholesterol. Deils hydrocarbon.Elementary ideas of HDL, LDL and Vitamin D.

Vitamins:classification, uses and deficiency diseases.

References

1. I. L. Finar, Organic Chemistry, Vols. 1 & 2, 5th Edn., Pearson Education, 2005
2. V. K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, 2nd Edn., Ane Books India, 2013
3. P. Sykes, A guide to mechanism in Organic Chemistry, 6th Edn., Pearson Education, 2004
4. P. S. Kalsi, Organic Reactions and Their Mechanisms, 8th Edn.,New Age International, 2014
5. J. March, Advanced Organic Chemistry, 6th Edn., John Wiley & Sons, 2007
6. J. Clayden, N. Greeves,S. Warren,Organic Chemistry, 7th Edn., Oxford University Press, 2012
7. R. T. Morrison and R. N. Boyd, Organic Chemistry, 6th Edn.,Prentice–Hall, 2004
8. K. S. Tewari and N.K. Vishnoi, Organic Chemistry, 3rd Edn., Vikas Publishing House
9. M. K. Jain and S. C. Sharma, Modern Organic Chemistry, 3rd Edn., Vishal Publishing Company
10. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Macmillan, 1984
11. B. S. Bahl ‘Advanced organic Chemistry’, S. Chand

SEMESTER V
PHYSICAL CHEMISTRY - II

Credits: 2 36 hrs

Unit I: Thermodynamics (12 hrs)

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroeth law of thermodynamics.

First law:concept of heat, *q*, work, *w*, internal energy *U* and statement of first law, enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Thermochemistry:heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature,explosion temperature. Carnot's theorem,cycle,efficiency of heat engine.Partial molar properties,Clausius-Clapeyron equation, chemical potential.

Second Law:concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Unit II: Chemical Equilibrium (12 hrs)

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.Thermodynamic derivation of relation between Gibbs freeenergy of reaction and reaction quotient.

Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p, $K_c$and K_x. LeChatelier principle (quantitative treatment), equilibrium between ideal gases and a pure condensed phase.

Unit III: Phase Equilibrium (12 hrs)

Concept of phases, components and degrees of freedom, Gibbs Phase Rule for non-reactive and reactive systems.One component systems: water and sulphur systems. Two component systems: solid – liquid equilibrium – potassium iodide – water system, freezing mixtures. Simple eutectic – Lead – silver system.Formation of compounds with congruent melting point – ferric chloride – water system.Incongruent melting point. Solid – gas equilibrium – salt hydrate. Thermal analysis: cooling curve.Nernst distribution law: derivation and applications.

Solutions:dilute solutions; lowering of vapour pressure, Raoult's and Henry's laws and their applications.Thermodynamic derivation using chemical potential to derive relations between the four colligative properties (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) depression of freezing point and (iv) osmotic pressure and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Reference

1. B. R. Puri, L. R. Sharma and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company, Jalandhar, 2010
2. K. L. Kapoor, Physical Chemistry, Vol. I, II, III & IV, Mac Millan (India) Ltd., 2000
3. P. Atkins and J. de Paula, Atkin's Physical Chemistry, 7th Edn., Oxford University Press, 2006
4. F. A. Alberty and R. J. Silby, Physical Chemistry, 3 rd Edn., John Wiley & Sons, 2004
5. J. Rajaram and J. C. Kuriakose, Thermodynamics, Shoban Lal Nagin Chand & Co.,1986
6. G. K. Vemulapalli, Physical Chemistry, Prentice Hall of India Pvt. Ltd., 1997

SEMESTER VI
INORGANIC CHEMISTRY - IV

Credits: 3 54 hrs

Unit I:Inorganic Polymers, Clusters, Bio-inorganic Chemistry (18 hrs)

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes, phosphazenes and polysulphates.

Clusters: Metal clusters - carbonyl and halide clusters, low nuclearity carbonyl clusters and high nuclearity carbonyl clusters, electron counting schemes for $Rh_6(CO)_{16}$ and $[Os_6(CO)_{18}]^{2-}$, metal only clusters (Zintl ions). Quadruple bond - structure of $Re_2Cl_8^{2-}$.

Bioinorganic chemistry:Elements of life - essential major, trace and ultra trace elements. Basic chemical reactions in the biological systems and the role of metal ions (specially Na^+, K^+, $Mg^{2+,}$ Ca^{2+}, $Fe^{3+/2+}$, $Cu^{2+/+}$, and Zn^{2+}).Metal ion transport across biological membrane Na^+ion pump, ionophores. Biological functions of haemoglobin and myoglobin, cytochromes and feridoxins, carbonate bicarbonate buffering system and carbonic anhydrase. Biological nitrogen fixation.Photosynthesis: Photosystem-I and Photosystem-II. Toxic metal ions and their effects, chelation therapy (examples only), Pt and Au complexes as drugs (examples only).

Unit II: Nanomaterials, Metallurgy,Refractory Materials (18 hrs)

Nanomaterials – classification, synthesis – chemical precipitation, mechanic-chemical method, micro emulsion method, reduction technique, chemical vapour deposition and sol-gel method (brief study). Fullerenes and carbon nanotubes (elementary idea only).

Metallurgy: occurrence of metals based on standard electrode potential, methods of concentration of ores, reduction to free metal, electrometallurgy, hydrometallurgy. Refining of metals, electrolytic, ion exchange, zone refining, vapour phase refining and oxidative refining. Thermodynamics of the oxidation of metals to metal oxides - Ellingham diagrams.

Refractory materials: carbides, nitrides, borides. Graphite and graphite oxide, intercalation compounds of alkali metals, carbon monofluoride, intercalation compounds of graphite with metal halides, glass, silicates, zeolites, ultramarines and ceramics.

Unit III: Analytical Methods in Chemical Analysis (18hrs)

Optical methods of analysis: origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.

UV-Visible spectrometry:basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principle of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers.

Infrared spectrometry: basic principle, instrumentation (choice of source, monochromator and detector) for single and double beam instrument; sampling techniques, and applications.

Flame atomic absorption and emission spectrometry:basic principle, instrumentation (choice of source, monochromator, detector, choice of flame and burner designs). Techniques of atomization, sample introduction, analysis and application (basic idea only).

Thermal method of analysis: theory of thermogravimetry (TGA), basic principle and instrumentation.Techniques for quantitative estimation of Ca and Mg from their mixture.

Electro analytical methods:classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence point.

References

1. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edn. Pearson Education, 2006
2. J. D. Lee, Concise Inorganic Chemistry, 5th Edn, Chapman & Hall, 2002
3. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd Edn., Oxford University Press, New Delhi, 2004
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5. F. A. Cotton. and G. Wilkinson, Advanced Inorganic Chemistry, 1st - 6th Edns., Wiley Interscience, 1962, 1966, 1972, 1980, 1988, 1999
6. D. A. Skoog, F. James Holler, Stanley R. Crouch, Principles of Instrumental Analysis, 6th Edition, Thomson Asia Pvt. Ltd., London, 2006
7. A. Cottrel, An Introduction to Metallurgy, 2ndEdn., University Press
8. V. S. Muraleedharan and A. Subramania, Nanosciece and Nanotechnology, Ane Books Pvt. Ltd., New Delhi, 2009
9. T. Pradeep, Nano; The Essentials, Mc Graw-Hill Education, New Delhi,2006.

SEMESTER VI
ORGANIC CHEMISTRY - IV

Credits: 3 54 hrs

Unit I: Organic Spectroscopy (18 hrs)

General principles introduction to absorption and emission spectroscopy.UV Spectroscopy:types of electronic transitions, λ_{max}, chromophores and auxochromes, bathochromic and hypsochromic shifts, intensity of absorption.Application of Woodward rules for calculation of λ_{max} for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters,conjugated dienes - alicyclic, homoannular and heteroannular, extended conjugated systems (aldehydes, ketones and dienes), distinction between cis and trans isomers.

IR Spectroscopy: fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of hydrogen bonding, conjugation, resonance and ring size on IR absorptions. Fingerprint region and its significance, application in functional group analysis.

NMR Spectroscopy: basic principles of proton magnetic resonance, chemical shift and factors influencing it; spin – spin coupling and coupling constant.Anisotropic effects in alkene, alkyne, aldehydes and aromatics, interpretation of NMR spectra of simple compounds.

Unit II: Polymers (9 hrs)

Introduction and classification of polymers,structure and main features of common polymers like PE, PP, PVC, PMMA, PET, PTFE, nylon-6, nylon-6,6, PAN, PEG, SAN, PF, PU, NR, SBR, NBR, PB, polychloropreneand thiokol rubber, different molecular weight averages, Polydispersity Index. Determination of molecular weight by GPC, Glass transition temperature (T_g) of polymers. Polymerisation reactions:addition and condensation. Synthesis of PVC, PMMA, PAN, polyamides (nylon 66, nylon 6), phenol-formaldehyde resin, polyurethanes.Vulcanization of rubber (hot and cold),biodegradable and conducting polymers with examples.

Unit III: Dyes (5 hrs)

Dyes: classification, colour and constitution,mordant and vat dyes.Synthesis and applications of: azo dyes – methyl orange and congo red (mechanism of Diazo Coupling); triphenyl methane dyes - malachite green, rosaniline and crystal violet; phthalein dyes – phenolphthalein and fluorescein;natural dyes –structure and synthesis of alizarin and indigotin. Edible dyes with examples.

Unit IV:Medicinal Chemistry (4 hrs)

Drugs- mode of drug action.Classification of drugs,structureand uses of sulpha drugs, chlorampheicol and pencillin.Antimalarial drugs, antipyretic dugs and analgestic drugs (structure, mode of action- basic idea).Anti cancer drugs.

Unit V: Pericyclic Reactions (12 hrs)

Pericyclic andphotochemical reactions: definition and classification.Electrocyclic reactions: FMO approach, example of electrocyclic reactions (thermal and photochemical) involving 4π and 6π electrons and corresponding cycloreversion reaction.Cycloaddition

reactions: FMO approach, Diels Alder reaction, photochemical [2+2] reactions. Sigmatropic shifts and their orders, [1, 3] and [1, 5] hydrogen shifts and [3, 3] shifts with reference to Claisen and Cope rearrangement.

Unit V: Reagents and Special Reagents (6 hrs)

Analytical Reagents: Tollen's reagent, Fehling solution, Schiffs reagent, Borsches reagent, Benedict's solution.

Utility of some reagents: n – Bu_3SnH, boranes, trimethyl silyl chloride, sulfonium and sulfoxonium ylides, diethyl azodicarboxylate, hydrogen peroxide, N-bromosuccinimide, DDQ, m - CPBA, $Pb(OAc)_4$, periodic acid, osmium tetroxide, LDA.(Structure and common applications only).

References

1. I. L. Finar, Organic Chemistry, Vols. 1 & 2, 5th Edn., Pearson Education, 2005
2. P. S. Kalsi, Organic Reactions and Their Mechanisms, 8th Edn.,New Age International, 2014
3. J. March, Advanced Organic Chemistry, 6th Edn., John Wiley & Sons, 2007
4. J. Clayden, N. Greeves,S. Warren,Organic Chemistry, 7th Edn., Oxford University Press, 2012
5. R. T. Morrison and R. N. Boyd, Organic Chemistry, 6th Edn.,Prentice–Hall, 2004
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7. K. S. Tewari and N.K. Vishnoi, Organic Chemistry, 3rd Edn., Vikas Publishing House
8. W. Kemp, Organic Spectroscopy, Longman, 1995
9. D. L. Pavia, G. M. Lampman and G. S. Kriz, Introduction to Spectroscopy, Thomson Brooks Cole.
10. Paula Y. Bruice, Organic Chemistry, 3rd Edn. Pearson Education Asia

SEMESTER VI
THEORETICAL CHEMISTRY - II

Credits: 3 54 hrs

Unit I: Spectroscopy - I (18 hrs)

Interaction of electromagnetic radiation with molecules and various types of spectra; Factors affecting width and intensity, Born- Oppenheimer approximation.

Rotation spectroscopy: selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

Raman spectroscopy: classical and quantum theories, qualitative treatment of rotational Raman effect, vibrational Raman spectra, Stokes and anti-Stokes lines, rule of mutual exclusion.

Unit II: Spectroscopy- II (12 hrs)

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.

Nuclear Magnetic Resonance (NMR) spectroscopy: principles of NMR spectroscopy, Larmor precession, chemical shift, low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of simple organic molecules.

Electron Spin Resonance (ESR) spectroscopy: principle, hyperfine structure, ESR of simple radicals like methyl, ethyl etc.

Unit III: Statistical Mechanics (6 hrs)

Statistical Mechanics: macrostates and microstates, thermodynamic probability, entropy and probability, statistical interpretation of third law of thermodynamics.equipartition principle and heat capacity.Boltzman exponential law (no derivations).Boltzons,Bosons,Fermions(basic ideas only) and their arrangements.

Unit IV: Solid State (12 hrs)

Solid State:nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method.Interpretation of XRD pattern of NaCl, KCl and CsCl.

Detailed study of simple cubic, bcc and fcc structures. Packing efficiency, density of unitcells.Voids (Td, Oh and cubic), radius ratio. Close packing of spheres- typesand coordination numbers. Structure of common ionic compounds like NaCl, ZnS, CsCl, CaF_2, Na_2O, spinels and inverse spinels.

Electrical properties of crystals: superconductivity, pyro electricity, piezoelectricity.Magnetic properties: ferro, ferri and anti ferro magnetism, curie temperature.

Defects in crystals: Schottky, Frenkel, Metal excess, Metal deficiency, thermal defects.
Glasses and liquid crystals: nematic, smetic and cholestric- thermographic behaviour.

Unit V: Group Theory (6 hrs)

Group theory: molecular symmetry and symmetry groups - symmetry elements and operations. Symmetry planes, inversion centre, proper/improper axes and rotations. Group multiplication table of C_{2v} and C_{2h}, molecular symmetry and optical isomerism, symmetry point groups, classification of molecular point groups. (30 molecules should be analysed to assign point groups)

References

1. Mc Quarrie, J. D. Simon, Physical Chemistry – A molecular Approach, Viva Books Pvt. Ltd.
2. C. N. Baanwell and E. M. Mc Cash, Fundamentals of Molecular Spectroscopy, 4thEdn., Tata Mc Graw Hill
3. B. R Puri, L. R Sharma and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company, Jalandhar, 2010
4. K. L. Kapoor, Physical Chemistry, Vol. I, II, III & IV, Mac Millan (India) Ltd., 2000
5. P. Atkins and J. de Paula, Atkin's Physical Chemistry, 7th Edn., Oxford University Press, 2006
6. Ira N. Levine, Physical Chemistry, 6th Edn., Mc Graw Hill, 2009
7. K. J. Laidler, J. H.Meiser, Physical Chemistry,2ndEdn.
8. D. L. Pavia, G. M. Lampman, G. S. Kriz, Introduction to spectroscopy 3rdEdn., Thomson Brooks/Cole, 2001
9. D. N. Satyanarayana, Electronic Absorption Spectroscopy and Related Techniques,Universities Press
10. G. K. Vemulapalli, Physical Chemistry, Prentice Hall of India Pvt. Ltd., 1997

SEMESTER VI
PHYSICAL CHEMISTRY - III

Credits: 3 54 hrs

Unit I: Electrical Conductance and EMF (18 hrs)

Conductance:Faraday's laws of electrolysis, measurement of conductance, cell constant, specific conductance and molar conductance. Variation of specific and equivalent conductance with dilution for strong and weak electrolytes.Kohlrausch's law of independent migration of ions, ion conductance and ionic mobility.Equivalent and molar conductance at infinite dilution and their determination for strong and weak electrolytes.Ostwald's dilution law. Debye-Huckel model (physical idea only). Application of conductance measurement (determination of solubility product and ionic product of water). Conductometric titrations.Determination of transport number by moving boundary method.

Electrochemical Cells: types of electrochemical cells and examples , cell reactions, emf and change in free energy, ΔH and ΔS and equilibrium constant of cell reactions from emf measurements. Thermodynamic derivation of Nernst equation.Standard cells,halfcells/electrodes, different types of electrodes (with examples).Standard electrode potential (IUPAC convention) and principles of its determination.Determination of pH values using hydrogen, quinone-hydroquinone and glass electrodes.Potentiometric titrations: acid-base and redox. Rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.

Concentration cells: electrode concentration cell and electrolyte concentration cells. Types of electrolyte concentration cells – with transference and without transference, liquid junction potential. Over voltage, oxygen over voltage, factors affecting over voltage.

Primary and secondary cells:dry cell, lead acid cell, Li-Cd cell, mercury cell. Fuel cells: hydrogen-oxygen fuel cell, hydrocarbon cell. Corrosion: different types of corrosion, theories of corrosion, corrosion monitoring and prevention methods. Polarography, half wave potential, Ilkovicequation and application in quantitative analysis (elementary ideas only).

Unit II: Ionic Equilibrium (18 hrs)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Theories of acids and bases: Arrhenius theory, acids and bases in protic solvents, Bronsted-Lowry theory, Lewis theory, the solvent system, Lux-Flood definition, Usanovich definition; hard and soft acids and bases-HSAB principle.Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and tri- protic acids (exact treatment).

Salt hydrolysis: calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts, applications of solubility product principle.

Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Mathematical treatment of acid base titrations.Theory of acid - base indicators, action of phenolphthalein and methyl orange as indicators.Selection of indicators and their limitations.Multistage equilibria in polyelectrolyte systems, hydrolysis and hydrolysis constants.

Unit III: Electrical Properties of substances (6 hrs)

Electrical properties of molecules: polarisability of atoms and molecules, dielectric constant and polarisation, molar polarisation for polar and non-polar molecules. Clausius-Mosotti equation and Debye equation and their application. Determination of dipole moments.

Unit IV: Surface Chemistry and Catalysis (12 hrs)

Surface Chemistry: adsorption and surface phenomena,physisorption and chemisorption of gases, adsorption isobar, isostere and isotherms, Freundlich adsorption isotherm, derivation of Gibbs and Langmuir isotherm, BET equation (derivation not required) and its use in surface area determination, nature of adsorbed state, adsorption and heterogeneous catalysis, surface film.

Colloids:electrical double layer and colloid stability, electrokinetic phenomena, soaps and detergents, micelle formation and critical micelle concentration.

Catalysis:types of catalyst, specificity and selectivity, mechanisms of catalysed reactions at solid surfaces.Auto catalysis, enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

References

1. B. R Puri, L. R Sharma and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company, Jalandhar, 2010
2. K. L. Kapoor, Physical Chemistry, Vol. I, II, III & IV, Mac Millan (India) Ltd., 2000
3. P. Atkins and J. de Paula, Atkin's Physical Chemistry, 7th Edn., Oxford University Press, 2006
4. F. A. Alberty and R. J. Silby, Physical Chemistry, 3 rd Edn., John Wiley & Sons, 2004
5. J. J. Bikermann, Surface chemistry, Academic press
6. A. W. Adamson, Physical Chemistry of Surfaces
7. Delmon, Catalysis: Heterogeneous and Homogeneous, Elsevier science,

SEMESTER VI
ENVIRONMENTAL CHEMISTRY

Credits: 3 54 hrs

Unit I: Environmental Management and Impact Assessment (5 hrs)

Basic principles, concepts and scope of environmental planning, conservation of energy – renewable and non-renewable energy sources-nuclear energy, solar energy, hydrogen, non-conventional energy sources. Environmental pollution: concepts and definition. Impact assessment: aim, concepts and methods.

Environmental pollution: definition, pollutants, classification and causes, prevention of pollution.

Unit II: Chemical Toxicology (10 hrs)

Toxicity: effects, toxic chemicals in the environment, impact of toxic chemicals on enzymes, biochemical effects of As, Cd, Pb, Hg, Co, NO_x, SO_2 , O_3, PAN, cyanide, pesticides, carcinogenic substances.

Unit III: Air Pollution (10 hrs)

Primary pollutants, hydrocarbons, photochemical smog, particulates, effects of atmospheric pollution - acid rain, ozone layer depletion. Indoor air pollution. Effect of electric and magnetic fields in the environment. Air pollution accidents: Bhopal and Chernobyl. Air quality standards:sampling and analysis of pollutants – CO, SO_2, H_2S, hydrocarbons, SPM. Noise pollution: measurement, classification, hazards.

Unit IV: Water Pollution (17 hrs)

Different water body systems, impact of nutrients on the water body, types, effects and sources of water pollution. Pollution of fresh water, ground water and ocean.Thermal pollution. Sampling and measurement of water quality odour,colour,EC,turbidity,TDS,salinity, COD, BOD, DO, coliform, pH, acidity, CO_2, alkalinity, hardness, nitrate, nitrite, NH_3, phosphate, fluoride, chloride, cyanide, sulphide, sulphate and metals- As, Cd, Fe, Pb, Hg,SAR,WQI. Water quality parameters and standard. Case study: Kuttanadu wetland. Waste water treatment techniques.

Unit V: Lithosphere (6 hrs)

Composition of soil - reactions in soil.Wastes and pollutants in soil. Sampling procedures and analysis of soil- cation exchange capacity, lime status, lime requirement, gypsum requirement, pH, N, P, K, S, Ca, Mg. Management of solid waste.

Unit VI: Radioactive Pollution (6hrs)

Definition, sources of radiation, natural and manmade radiations, types of radiation – electromagnetic radiation and atomic radiation, biological effects of radiation, control of radioactive pollution.

Reference

1. A. K. De, Environmental Chemistry, New Age International Pvt.Ltd.
2. G. T. Tyler, Living in the Environment, Tomson Brooke/Cole

3. N. Manivasakam, Physico-Chemical Examination of Water, Sewage and Industrial Effluents, Pragathi Prakashan
4. D .Clarson, Soil and Water Analytical Methods, ISBN:81-901483-0-3.
5. R. K. Khitoliya, Environmental Pollution – Management and Control for Sustainable Development, S.Chand & Company Ltd.
6. B. Kebbekus and S. Mitra, EnvironmentalChemical Analysis, Blacke Academic & Professional
7. S. S.Dara, A Textbook of Environmental Chemistry and Pollution Control, S.Chand & Company Ltd.
8. R. A. Malaviya, Environmental Pollution and its Control under International Law
9. Pramod Singh, Environmental Pollution Management
10. G. K. Ghosh, Environmental Pollution – A Scientific Study
11. Nelson L. Numerow, Industrial Water Pollution
12. James W. Moore and S.Ramamoorthy, Organic Chemicals in Natural Waters
13. Hutzinger, Aquatic Pollutants
14. F. Kreith, Handbook of Solid Waste Management, Mc Graw Hill
15. Standard Methods for Examination of Water and Waste Water, APHA
16. Peter O' Neil, Environmental Chemistry, Blackie Academic and Professional, London
17. S. P. Mishra and S. N. Pandey, Essential Environmental Studies, Ane Books Pvt. Ltd, New Delhi
18. V. K. Ahluwalia, Environmental Chemistry, Ane Books Pvt. Ltd., New Delhi
19. H. D. Kumar, Modern Concepts of Ecology, 8th Edn., Vikas Publishing House Pvt. Ltd., 2006

PRACTICAL COURSE
SEMESTER I & II

QUALITATIVE INORGANIC ANALYSIS

Credits: 2 **72 hrs**

Systematic qualitative analysis of mixtures containing two cations and two anions from the following with one interfering radical by semi-micro method only.Identification and confirmation tests (with chemistry) and spot tests expected.

Ag^{+}, $Hg^{2+,}$ $Pb^{2+,}$ Cu^{2+}, Bi^{2+} , Cd^{2+}, As^{3+}, Sn^{2+}, Sb^{3+} , $Fe^{2+,}$ Fe^{3+} , $Al^{3+,}$ Cr^{3+} , Zn^{2+}, Mn^{2+} , Co^{2+} , Ni^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+} , Mg^{2+} , Li^{+}, Na^{+}, K^{+}, NH_4^{+}, $CO_3^{2-,}$ S_2^{2-}, SO_4^{2-}, NO_3^{-}, F^{-}, Cl^{-}, Br^{-}, BO_2^{-} $C_2O_4^{2-}$, $C_4H_4O_6^{2-}$, CH_3COO^{-}, PO_4^{3-},AsO_3^{3-}, AsO_4^{3-} and CrO_4^{2-}

Interfering anions: F^{-}, BO_2^{-},$C_2O_4^{2-}$, $C_4H_4O_6^{2-}$,PO_4^{3-}, AsO_3^{3-}, $AsO_4^{3-,}$and CrO_4^{2-}

(Minimum of eight mixtures (with interfering anions) to be analysed)

Reference

1. G. Svehla, Vogel's Qualitative Inorganic Analysis, 7th Edn., Pearson Education, New Delhi, 2006
2. V. V. Ramanujam, Inorganic Semi micro Qualitative Analysis,The NationalPublishing Co., Chen

SEMESTER III & IV
QUALITATIVE ORGANIC ANALYSIS

Credits: 2 **72 hrs**

1. Tests for elements: nitrogen, halogens and sulphur
2. Tests for unsaturation
3. Tests for aromatic character
4. Study of the reactions of the following functional groups: alcohol, aldehyde, ketone, carboxylic acid, 1,2-dicarboxylic acid, ester, primary, secondary and tertiary amines
5. Systematic analysis of the following organic compounds containing one functional group and characterization with a derivative.- alcohol, aldehyde, ketone, carboxylic acid, dicarboxylic acid (aliphatic and aromatic), ester, primary and secondary amines halogen in nucleus and side chain, carbohydrates, diamides (urea and thiourea), amides, anilides, nitro compounds, primary, secondary and tertiary amines.
6. Preparation of solid derivative by modification of functional groups as possible
7. Melting and boiling points of the substance given for the analysis

Systematic Analysis using preliminary, identification and confirmatory tests and derivative preparation with chemical equations for all positive tests expected.
(Minimum ten compounds to be analysed)

Reference

1. Vogel's Textbook of Practical Organic Chemistry' Pearson Education
2. F. G. Mann and B. C. Saunders, Practical Organic Chemistry, 4th *Edn.*,Pearson Education
3. V.K.Ahluwalia and S. Dhingra, Comprehensive Practical Organic Chemistry, Universities Press

SEMESTER V & VI
ORGANIC CHEMISTRY PRACTICAL II

Credits: 6 **104 hrs**

Chromatography

TLC

Separation and identification- Determination of R_f value of*o*-and *p*- nitroanilines - benzil and *o*-nitroaniline *ortho* and *para* chloroanilinesor any two amino acids

Column Chromatography

Purification of *o*-nitro aniline, m- dinitro benzene, benzene azo–β-naphthol.(non-evaluative)

Organic preparations involving single step (Evaluative)

(Any 5 preparations to be done in the laboratory. The following are only a few examples)

1. Acylation (benzoylation of aniline, phenol, β -naphthol)
2. Esterification (benzoic acid)
3. Iodoform from acetone or ethyl methyl ketone
4. Side chain oxidation (benzyl chloride to benzoic acid)
5. Claisen – Schmidt (dibenzal acetone from benzaldyde)
6. Nitration of benzoic acid and acetanilide

Quantitative analysis(Non-Evaluative)

1. Milk analysis
2. Oil analysis- saponification value, iodine value
3. Latex analysis

Reference

1. Vogel's Textbook of Practical Organic Chemistry' Pearson Education
2. F. G. Mann and B. C. Saunders, Practical Organic Chemistry, 4th*Edn.*, Pearson Education
3. V. K. Ahluwalia and S. Dhingra, Comprehensive Practical Organic Chemistry, Universities Press
4. A. I. Vogel, A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis, 3rd Edn., ELBS

SEMESTER V & VI
PHYSICAL CHEMISTRY PRACTICAL

Credits: 4 **72 hrs**

1. Critical solution temperature -phenol-water system
2. Determination of molecular weight by Rast's Method (using naphthalene, camphor or biphenyl as solvent and acetanilide, p-dichlorobenzene etc. as solute.)
3. Kinetics of simple reactions (eg. Acid hydrolysis of methyl acetate)
4. Potentiometric titration – Fe^{2+} *vs.* $Cr_2O_7^{2-}$, I^- *vs.* MnO_4^-, strong acid- strong base, weak acid-strong base
5. Data analysis of kinetic experiments using spread sheet program (determination of rate constant)
6. Determination of equivalence point of potentiometric and conductometric titrations using spread sheet program
7. Colorimetric analysis

Reference

1. W. G. Palmer, Experimental Physical Chemistry, Cambridge University Press
2. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House
3. R. C. Das and B. Behra, Experiments in Physical Chemistry, Tata McGraw Hill
4. K. K. Sharma, An Introduction of Practical Chemistry, Vikas Publishing House, New Delhi

SEMESTER V & VI
GRAVIMETRIC ANALYSIS

Credits: 6 **104 hrs**

1. Estimation of Barium as $BaSO_4$
2. Estimation of sulphate as $BaSO_4$
3. Estimation of magnesium as oxinate
4. Estimation of iron as Fe_2O_3
5. Estimation of Nickel as dimethyl glyoxime complex
6. Estimation of copper as CuCNS

Reference

1. A. I. Vogel, A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis, 3rd Edn., ELBS
2. J. Bassett, R.C.Denney, G. H. Heffery and J Mendham, Vogel's Textbook of Quantitative Inorganic Analysis (revised), ELBS

SEMESTER V & VI
VOLUMETRIC ANALYSIS

Credits: 4 **72 hrs**

Acidimetry and Alkalimetry

1. Strong acid – Weak base
2. Strong base – Weak acid
3. Estimation of Na_2CO_3 and $NaHCO_3$ in a mixture
4. Estimation of NaOH and Na_2CO_3 in a mixture
5. Estimation of ammonia in ammonium salts by direct and indirect methods

Permaganometry

1. Estimation of oxalic acid
2. Estimation of Mohr's salt
3. Estimatrion of calcium
4. Estimation of ferric iron

Dichrometry

1. Estimation of ferrous iron using internal indicator
2. Estimation of ferrous iron using external indicator
3. Estimation of ferric iron using internal indicator
4. Estimation of ferric iron using external indicator

Complexometry

1. Estimation of Zn using EDTA
2. Estimation of Mg using EDTA
3. Estimation of Mg and Ca in a mixture
4. Estimation of Ni
5. Determination of hardness of water

Reference

1. D. A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry 8thEdn.
2. Vogel's Textbook of Quantitative Chemical Analysis 6thEdn, Pearsons Education Ltd.
3. G. D. Christian, Analytical Chemistry, John Wiley and Sons
4. R. D. Day, A. L. Uderwood, Quantitative anAlysis,6th Edn.,Prentice Hallof India Pvt.. Ltd.

COMPLEMENTARY COURSE

The following table shows the structure of the complementary courses which indicate course code, title of the courses, instructional hours, credits, examination time. The components for internal and external evaluation are the same as that of core courses offered by the department.

Detailed Scheme of Instruction of the Complementary Course

Sl. No.	Course Code	Title of the Course	Exam Duration (hrs)	Credit per Course	Instructional hrs for course	Instructional hours /week
Semester I						
1.	DCH101	Basic Theoretical and Analytical chemistry	3	2	36	2
2.		Practical: Volumetric Analysis (Common to Physical Sciences and Life Sciences)	-	-	36	2
Semester II						
3.	DCH202	Basic organic chemistry	3	2	36	2
4.	DCH2P01	Practical: Volumetric Analysis (Common to Physical Sciences and Life Sciences)	3	2	36	2
Semester III						
5.	DCH303	Advanced Physical Chemistry-I (For students who have opted Physical Sciences)	3	3	54	3
6.		Advanced Inorganic and Organic Chemistry (For students who have opted Life Sciences)	3	3	54	3
7.		Practical: Physical Chemistry Practical (For students who have opted Physical Sciences)	-	-	36	2
8.		Organic Chemistry Practicals (For students who have opted Biological Sciences)	-	-	36	2

Semester IV						
7.	DCP404	Advanced Physical Chemistry-II (For students who have opted Physical Sciences)	3	3	54	3
8.	DCB404	Advanced Bio-organic Chemistry (For students who have opted life sciences)	3	3	54	3
9.	DCP4P02	Practical: Physical Chemistry Practical (For students who have opted Physical Sciences)	3	2	36	2
10.	DCB4P02	Organic Chemistry Practicals (For students who have opted Biological Sciences)	3	2	36	2

SEMESTER I
BASIC THEORETICAL AND ANALYTICAL CHEMISTRY
(COMMON TO PHYSICAL SCIENCES AND LIFE SCIENCE)

Credits- 2 **36 hrs**

Unit I: General Introduction (15 hrs)

General principle, types of titrations,requirements for titrimetric analysis. Concentration systems: Molarity, formality, normality, weight percentage, ppm, milli equivalence and milli moles - problems. Primary and secondary standards, criteria for primary standards, preparation of standard solutions, standardization of solutions. Limitation of volumetric analysis, endpoint and equivalence point**.**

Acid-base equilibria: pH of strong and weak acid solutions. Buffer solutions, Henderson equation,preparationof acidic and basic buffers. Relative strength of acids and bases from K_a and K_b values.Neutralisation-titration curve, theory of indicators, choice of indicators, use of phenolphthalein and methyl orange.

Complexometric titrations: stability of complexes, titration involving EDTA,metal ion indicators and characteristics.

Solubility and solubility products, expressions for solubility products,determination of solubility from solubility products, common ion effect.

Gravimetric method of analysis: general principle-separation by precipitation. Separation and purification techniques: Recrystallisatoin, use of drying agents, sublimation. General principles of distillation, fractional distillation, distillation under reduced pressure. Solvent extraction.

Unit II: Analytical Techniques (12 hrs)

Principle of adsorption and partition chromatography. Column chromatography: adsorbents, classification of adsorbents, solvents, preparation of column, adsorption and applications. Thin Layer Chromatography: choice of adsorbent, choice of solvent, preparation of chromatogram, sample, R_f value and its applications. Paper chromatography, solvent used, R_f value, factors which affect R_f value. Ion exchange chromatography, resins used, experimental techniques, applications. Gas Chromatography, High performance liquid chromatography principle, and applications

Thermal analytical methods, principle involved in thermogravimetric analysis and differential gravimetric analysis, characteristics of TG and DTA, factors affecting TG and DTA curves.

Unit III: Principles of Thermodynamics (9 hrs)

Statement of second law of thermodynamics and their equivalence, Carnot's cycle and Carnot's theorem, Absolute scale of temperature, concept of Entropy as a state function, Entropy changes in various physical processes.

Clausius inequality, condition of reversibility and irreversibility of a process, auxiliary state function-Helmholtz free energy and Gibbs free energy and their simple applications.Open systems: Partial molar quantities, Chemical potential and its expression for ideal gas, concept of standard states.

Reference

1. D.A. Skoog, D.M. West and F.J. Holler, Analytical Chemistry: An Introduction, 5th Edn., Saunders college publishing, Philadelphia, 1990.
2. B. R Puri, L. R Sharma and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company, Jalandhar, 2008.
3. Vogel's Text Book of Quantitative Chemical Analysis, J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, 6th Edn., Pearson Education, 2003.
4. R. Gopalan, Analytical Chemistry, S. Chand and Co., New Delhi.

SEMESTER II
BASIC ORGANIC CHEMISTRY
(COMMON TO PHYSICAL SCIENCES AND LIFE SCIENCE)

Credits- 2 **(36 hrs)**

Unit I: Stereochemistry of Organic Compounds (13 hrs)

Geometrical isomerism: *cis* and *trans*- configuration, determination of configuration and interconversion of *cis-trans* isomers, E and Z configuration. Optical isomerism: optical activity, chirality, stereogenic centre, enantiomers and diastereomers, racemisation.Conformation: Newman projection, saw-horse projection, Conformations of ethane, *n*-butane, cyclohexane.

Unit II: Mechanisms of Organic Reactions (15 hrs)

Hybridization: sp^3, sp^2 and *sp*, (ethane, ethene, ethyne). Polarity of bonds, inductive, mesomeric and hyperconjugative effects. Bond fission: homolytic and heterolytic fission. Reaction intermediates- radicals, carbocations and carbanions.

Classification of reagents: electrophiles, nucleophiles. Types of organic reactions: addition, substitution and elimination reactions.

Substitution reactions: nucleophilic substitution of alkyl halides- S_N1 and S_N2 mechanisms.

Addition reactions: electrophilic addition to ethene, propene and ethyne-the Markwonikoff's rule, Peroxide effect.

Elimination reactions: E1 and E2 mechanisms

Unit III: Aromaticity (8 hrs)

Concept of resonance: resonance energy, heat of hydrogenation and heat of combustion of benzene, mention of C-C bond lengths and orbital picture of benzene. Structure of naphthalene and anthracene (Molecular orbital diagram and resonance energy).

Concept of aromaticity: aromaticity (definition), Huckel's rule – application to benzenoid -benzene, naphthalene and non– benzenoid compounds -cyclopropenyl cation, cyclopentadienyl anion and tropylium cation.

Reactions: general mechanism of electrophilic substitution, mechanism of halogenation, nitration, Friedel Craft's alkylation and acylation. Orientation of aromatic substitution– definition of *ortho*, *para* and *meta*- directing groups.

Reference

1. R. T. Morrison and R. N. Boyd, Organic Chemistry, 6th Edn.,Prentice–Hall, 2004.
2. I. L. Finar, Organic Chemistry, Vol. 1, 5th Edn., Pearson Education, 2005.
3. S. M. Mukherji, S. P Singh, R. P Kapoor, Organic Chemistry Vol.1, NewAge InternationalPvt. Ltd., 2006.
4. P. Sykes, A guide to mechanism in Organic Chemistry, 6thEdn., Pearson Education, 2004.
5. K. S. Tewari; N. K. Vishnoi; S. N. Mehrotra, A text book of organic chemistry, revised 2ndEdn., Vikas Publishing Pvt. Ltd., 2003.

SEMESTER III
ADVANCEDPHYSICAL CHEMISTRY - I
(FOR STUDENTS WHO HAVE OPTED PHYSICAL SCIENCES)

Credits- 3 **(54hrs)**

Unit I: Chemical Kinetics **(12 hrs)**

Arrhenius theory– determination of Arrhenius parameters. Collision theory of bimolecular gas phase reactions– derivation of rate equation. Collision theory of unimolecular reactions– Lindemann's equation, Hinshelwood's modification- Transition theory– Eyring's equation– Comparison of the theories- Kinetics of opposing, consecutive, parallel reactions. (first order examples)- Chain reactions– H_2-Cl_2 and H_2-Br_2 reaction– Steady state approximation. Branching chain– $H_2 + O_2$ reaction– explosion limits, Kinetics of reaction in solution– role of solvent– primary and secondary salt effects, Mechanism of heterogeneous catalysis– enzyme catalysis– Michaelis Menten theory.

Unit II: Chemical Thermodynamics **(15 hrs)**

Concept of free energy and entropy, Conditions for spontaneity of process, conditions for equilibrium, derivation of law of chemical equilibrium from thermodynamics, Van't Hoff reaction isotherm, study of dissociation equilibria $PCl_5 \rightarrow PCl_3 + Cl_2$, degree of dissociation from density measurements thermodynamics of dilute solutions – derivation of depression of freezing point and elevation of boiling point from thermodynamical consideration, lowering of vapour pressure and osmotic pressure– van't Hoffs laws of osmotic pressure, van't Hoff theory of dilute solution, association and dissociation of solutes, van't Hoff's factor phase rule- definition giving examples, derivation from thermo dynamics, simple eutectic system.

Unit III: Electrochemistry **(15 hrs)**

Debye Huckeltheory of strong electrolytes (derivation not required), Debye Huckel limiting law, Ionic strength theory of conductometric titrations, Thermodynamics of cell reactions– enthalpy– entropy, free energy changes from emf of cells– Nernst equation, potentiometric titration- theory. Corrosion: forms of corrosion, theories of corrosion, methods for corrosion control, Butter– Volmer and Tafel equations. Polarography: half wave potential, diffusion current, DME, Ilkovic equation– analytical applications.

Unit IV: Chemistry of Surfaces **(12 hrs)**

Adsorption: Langmuir adsorption isotherm, BET equation, Gibbs adsorption isotherm. Reactions at sufaces: unimolecular and bimolecular reactions, Langmuir - Hinshelwood mechanism. Colloidal surfactants: classification anionic, cationic and non- inorganic surfactants, micelles- structure, CMC, determination, stabilizing action of surfactants, sol-gel transformations, emulsions, applications of colloidal surfactants.

Reference

1. P. Atkins and J. de Paula, Atkin's Physical Chemistry, 7th Edn., Oxford University Press, 2006.
2. A. W. Adamson and A. P. Gast, Physical Chemistry of Surfaces, 6th Edn., John Wiley: New York, 1997.
3. K. J. Laidler, Chemical Kinetics, 3rd Edn., Pearson Education, New Delhi, 2004.
4. G. K. Vemulapalli, Physical Chemistry, Prentice Hall, New Delhi, 2004.
5. Jom Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol. 1&2, 2nd edn., Kluwer Academic Publishers, 1998.
6. B. R Puri, L. R Sharma and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company, Jalandhar, 2010.

SEMESTER III
ADVANCEDINORGANIC AND ORGANIC CHEMISTRY
(FOR STUDENTS WHO HAVE OPTED LIFE SCIENCES)

Credits- 3 **(54hrs)**

Unit I: Industrial Chemistry (15 hrs)

Fats – oils-detergents: fats and oils, natural fat, edible and inedible oil of vegetable origin. Common fatty acids, glycerides.Hydrogenation of unsaturated oil, production of vanaspati and margarine. Production of toilet and washing soaps, Enzyme based detergents, detergent powder, liquid soaps.

Fertilizers: Manufacture of ammonia and ammonium salts, urea, superphosphate, biofertilizers.

Pesticides: common pesticides. Production, applications and residual toxicity of gammaxane, aldrin, parathion, malathion, DDT, paraquat, decamethrin.

Food additives: food flavour, food colour, food preservatives, artificial sweeteners, acidulants, alkalies, edible emulsifiers and edible foaming agents, sequesterants– uses and abuses of these substances in food beverages.

Unit II: Applications of Chemical Principles to Biochemical Analysis (15 hrs)

Radioactivity:radioactive decay, average life of radio elements and its relation with half-life, radioactive equilibrium. Atomic Nucleus:fundamental particles of atomic nucleus, atomic number and its significance, nuclear stability, neutron-proton ratio and different modes of decay,nuclear binding energy. Nuclear reactions: artificial radioactivity, transmutation of elements, fusion, fission and spallation, Nuclear energy. Application of radionuclides in biomedical chemistry (principles): Application of gamma radiation, effect of radiation on biological cells and the chemical basis of radiation damage.

Radioisotopes in medicine: diagnosis of thyroid tumour, magnetic resonance imaging of diseased organs (thyroid, brain, kidney), diagnosis of heart disorders, treatment of thyroid cancer and blood cancer, radiation therapy in cancer.

Unit III:Heterocycles (6 hrs)

Introduction, five and six membered heterocycles containing one and two hetero atoms.Aromaticity of heterocyclic compounds, basicity of pyridine and pyrrole.Tautomerism in heterocyclic systems.Structural aspects and reactions of purines and pyrimidines.

Unit IV:Lipids (6 hrs)

Fatty acids- definition and classification, properties of saturated and unsaturated fatty acids.Esters of fatty acids- formation and hydrolysis, Essential fatty acids.Triacyl glycerols.Reactions and characterization of fats– hydrolysis, saponification value, iodine number, rancidity of fats. Biological significance of fats. Prostaglandins (brief introduction only).

Unit V:Steroids and Carotenoids (6 hrs)

Introduction, and importance, cholesterol (structure), modifications of sterols, bile acids, steroid hormones (structure and brief function), carotenes, lycopene (only structure and brief function).

Unit VI: Vitamins **(6 hrs)**

Water soluble vitamins: chemistry and biochemical functions of – thiamin, riboflavin, nicotinic acid, pyridoxine, pantothenic acid, pteroylglutamic acid, vitamin B_{12}, Biotin, L-ascorbic acid (Vitamin C). Fat soluble vitamins: chemistry and biochemical functions of vitamin A, D, E, K.

Reference

1. B. K. Sharma, Industrial Chemistry, Goel Publishing House, Meerut, 2003.
2. I. L. Finar, Organic Chemistry, Vols. 1 & 2, 5th Edn., Pearson Education, 2005.
3. M. K. Jain and S. C. Sharma, Modern Organic Chemistry, 4thEdn., Vishal Publishing Company, 2003.
4. K. S. Tewari and N. K. Vishnoi, Organic Chemistry, 3rdEdn., Vikas Publishing House.
5. R. T. Morrison and R. N. Boyd, Organic Chemistry, 6th Edn.,Prentice Hall, 2004.
6. Rastogi,S. C. Biochemistry, Tata Mc Graw Hill Publication, 2nd Edn, 2003.
7. C. N. R. Rao, University General Chemistry, Macmillan India (P) Ltd., 2nd Edn.,1973.
8. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers and Distributors, 2008.
9. H. J. Arinikar, Essentials of Nuclear Chemistry, 4thEdn., New Age International, New Delhi, 1995.

SEMESTER IV
ADVANCED PHYSICAL CHEMISTRY - II
(FOR STUDENTS WHO HAVE OPTED PHYSICAL SCIENCES)

Credits- 3 **(54hrs)**

Unit I: Photochemistry (9 hrs)

Grothus - Draper law, Stark - Einstein law, Beer - Lambert's law, quantum yield. Examples of reactions with high and low quantum yield and explanation.Jablonski diagram, fluorescence and phosphorescence, Photosensitisation, chemiluminescence, difference between photochemistry and radiation chemistry.Effect of ultrasonic sound and microwave radiation on chemical reactions.

Unit II: Molecular Symmetry and Group Theory (9 hrs)

Elements of symmetry of molecules: identity, proper axis of rotation, reflection plane, inversion centre, improper axis of rotation, Schonflies notation. Combinations of symmetry operations, mathematical group, point groups of simple molecules-CO_2, BF_3, NH_3, H_2O, *trans*-dichloroethylene. Group multiplication table for C_{2v}, C_{3v} and C_{2h}.

Unit III: Molecular Spectroscopy (18 hrs)

Interaction of electromagnetic radiation with matter, energy levels in molecules. rotationalspectrum, rigid rotator, expression for energy, selection rule, calculation of bond length, moment of inertia. Vibrational spectra of diatomic molecules: simple harmonic oscillator, selection rule, vibrational modes of CO_2 and H_2O, calculation of force constant. Raman spectroscopy: brief description, Stokes and anti-Stokes lines and their intensity difference, rotational Raman spectrum and its selection rules, mutual exclusion principle. Electronic spectroscopy: Frank - Condon principle, dissociation energy of diatomic molecule. NMR spectroscopy: principle, number of signals, position of signals, chemical shift, intensity of signals, spin-spin coupling, NMR spectra of simple organic molecules. ESR spectroscopy: theory, hyperfine splitting of methyl radical.

Unit IV: Solid State (18 hrs)

Law of constancy of interfacial angles, law of constancy of symmetry, law of rationality of indices, space lattice and unit cell, Miller indices, seven crystal systems and fourteen Bravais lattices. X-ray diffraction, Bragg's equation–derivation.briefdescription of rotating crystal method and powder method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Detailed study of simple, face centred and body centred cubic systems. Calculation of Avogadro number, Identification of cubic crystal from interplanar distance ratio. Close packing of spheres, packing of spheres in body centred cubic arrangement, structure of ionic compounds of the type AX (NaCl, CsCl, ZnS), AX_2 (CaF_2, TiO_2). Defects of crystals: Non stoichiometric and stoichiometric defects, point defects, Schotky defect and Frenkel defects. Extrinsic and intrinsic conduction. Liquid crystals: classification and its applications (theory not required).

Reference

1. B. R Puri, L. R Sharma and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company, Jalandhar, 2010.

2. P.L. Soni, O.P. Dharmarha and U.N. Dash, Text book of Physical Chemistry, 22nd Edn., Sultan Chand & Sons, New Delhi, 2011.
3. K.Veera Reddy,Symmetry and Spectroscopy of Molecules, New Age International Pvt. Ltd 1998.
4. L.V. Azaroff, Introduction to Solids, Mc Graw Hill, 34th reprint, 2010.
5. N.B. Hanna, Solid State Chemistry, Prentice Hall of India (P) Ltd. 1976.
6. Gurdeep Raj, Advanced Physical Chemistry, Goel Publishing House, Meerut, 35th edn., 2009.
7. S. Glasstone and D. Lewis, Elements of Physical Chemistry, McMillan Press Ltd., London, 2ndEdn., 1962.
8. P.W. Atkins, Physical Chemistry, 6THEdn., Oxford University Press, Oxford, 1998.

SEMESTER IV
ADVANCED BIO-ORGANIC CHEMISTRY
(FOR STUDENTS WHO HAVE OPTED LIFE SCIENCES)

Credits- 3 **(54hrs)**

Unit I: Bio-inorganic Chemistry (14 hrs)

Essential and trace metals in biological Systems: toxicity of metal ions such as Hg, Pb, Cd and As, reasons for toxicity. Biological membranes: structure and functions of biological membranes.Mechanism of ion transport across the membranes: active transport and passive transport, proton and Na- K pump, calcium pump.Dioxygen transport in biological systems: haemoglobin, myoglobin, haemocyanin and haemerythrins, cooperativity of haemoglobin. Iron storage and transport in biological systems: ferritin and transferrittin.Metalloenzymes: carboxy peptidase, carbonic anhydrase, structure and functions.Nitrogen fixation: chemistry of nitrogen fixation, nitrogenases.

Unit II:Techniques in Biology (12 hrs)

Principles of microscopy, light microscope; fluorescence microscopy, Sample Preparation for light microscopy, Electron microscopy (EM)- Scanning EM and scanning transmission EM (STEM), Sample Preparation for electron microscopy, X-ray diffraction analysis.

Unit III: Bio-organic Chemistry (18 hrs)

Carbohydrates: biological importance of carbohydrates, Metabolism, cellular currency of energy (ATP), glycolysis, alcoholic and lactic acid fermentations, Krebs cycle.

Amino acids:classification and structures; essential and non-essential amino acids, physical properties, zwitterions, isoelectric point, titration of amino acids, separation and analysis of amino acids.

Proteins: classification, biological importance; Primary, secondary and tertiary structures of proteins: α-helix and β- pleated sheets, denaturation of proteins.

Enzymes: nomenclature, characteristics (mention of Ribozymes) and classification; active site, mechanism of enzyme action, stereospecificity of enzymes, coenzymes and cofactors, enzyme inhibitors, introduction to bio-catalysis- Importance in "Green Chemistry" and chemical Industry.

Nucleic acids:nucleosides and nucleotides. Composition of RNA and DNA, complementary base- pairings, features of DNA double helix (Watson - Crick Model). Biological functions.

Energy rich molecules: elementary structure of ATP, ADP and AMP.

Unit IV: Pharmaceutical Compounds: Structure and Importance (10 hrs)

Classification, structure and therapeutic uses of antipyretics: paracetamol (with synthesis), analgesics: ibuprofen (with synthesis).Antimalarials: chloroquine (with synthesis). An elementary treatment of antibiotics and detailed study of chloramphenicol.Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Reference

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers and Distributors, 2008.
2. S.J. Lippard, andJ.M. Berg, Principles of Bioinorganic Chemistry,Panima Publishing Company, 1994.
3. N.A. Campbell and Reece J. B., Biology 8th Edn., Pearson Benjamin Cummings, San Francisco, 2008.
4. P. H. Raven, Biology 7th Edn., Tata McGraw Hill Publications, New Delhi, 2006.
5. D. L. Nelson, andM. M. Cox, Lehninger's Principles of Biochemistry, 4th Edn., W. H. Freeman, 2008.
6. J. M. Berg, J. L. Tymoczko, andL. Stryer, Biochemistry, W. H. Freeman, 7th Edn., 2010.
7. R. T. Morrison and R. N. Boyd, Organic Chemistry, 6th Edn.,PrenticeHall, 2004.
8. I. L. Finar, Organic Chemistry, Vol. 1,5th Edn., Pearson Education, 2005.

Practical

SEMESTER I& II
VOLUMETRIC ANALYSIS
(COMMON TO PHYSICAL SCIENCES AND LIFE SCIENCES)

Credits: 2 **72 hrs**

Acidimetry and Alkalimetry

1. Standardization of HCl with standard Na_2CO_3 solution
2. Standardization of NaOH with standard oxalic acid solution
3. Estimation of any acid using standard NaOH
4. Estimation of any alkali using standard HCl

Permanganometry

1. Standardization of $KMnO_4$ using (i) oxalic acid (ii) Mohr's salt
2. Estimation of Fe^{2+} in Mohr's salt and crystalline ferrous sulphate using standard $KMnO_4$

Dichrometry

1. Estimation of Ferrous ion (external indicator)
2. Estimation of Ferrous ion (internal indicator)
3. Estimation of $FeSO_4.7H_2O$ (external indicator)

Gravimetric Analysis

1. Determination of percentage of water in barium chloride crystals
2. Estimation of barium as barium sulphate
3.

Determination of Physical Constants of Organic Compounds

1. Melting point
2. Boiling point

Reference

1. D. A. Skoog, D. M. West, and S. R. Crouch, Fundamentals of Analytical Chemistry 8thEdn.,2004.
2. Vogel's Textbook of Quantitative Chemical Analysis 6thEdn, Pearsons Education Ltd, 2000.
3. G. D. Christian, Analytical Chemistry, JohnWiley and Sons, 6thEdn., 2004.
4. R.D Day, A.L. Underwood, Quantitative analysis,6thEdn.,Prentice Hall of India Pvt. Ltd., 1991.

SEMESTER III & IV
PHYSICAL CHEMISTRY PRACTICAL
(FOR STUDENTS WHO HAVE OPTED PHYSICAL SCIENCES)

Credits: 2 **72 hrs**

Determination of Partition coefficient of a non-volatile solute
Transition temperature of salt hydrates
Critical solution temperature of phenol water system
Heat of neutralization
Conductometric titration of strong acid vs. strong base
Potentiometric titrations: Fe^{2+} vs. $Cr_2O_7^{2-}$ and Fe^{2+} vs. $KMnO_4$
Kinetics of simple reactions

Reference

1. W. G. Palmer, Experimental Physical Chemistry, Cambridge University Press, 2nd Edn., 2009.
2. J. B. Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 29th Edn., 2010.
3. K. K. Sharma, An Introduction of Practical Chemistry, Vikas Publishing House, New Delhi, 1st Edn, 2003.

SEMESTER IV
ORGANIC CHEMISTRY PRACTICALS
(FOR STUDENTS WHO HAVE OPTED BIOLOGICAL SCIENCES)

Credits: 2 **72 hrs**

1. Tests for elements: nitrogen, halogens and sulphur
2. Determination of physical constants
3. Study of reactions of common functional groups
4. Qualitative analysis with a view to characterization of functional groups and identification of the following compounds: naphthalene, anthracene, chlorobenzene, benzyl chloride, p-dichlorobenzene, benzyl alcohol, phenol, o-, m- and p- cresols, -naphthol, resorcinol, benzaldehyde, accetophenone, benzophenone: benzoic acid, phthalic acid, cinnamic acid, salicylic acid, ethyl benzoate, methyl salicylate, benzamide, urea, aniline, o-, m- and p- toluidines, dimethyl aniline, nitrobenzene, o-nitrotoluene, m-dinitrobenzene and glucose.
   (Systematic Analysis using preliminary, identification and confirmatory tests and derivative preparation with chemical equations for all positive tests expected-Minimum ten compounds to be analysed)
5. Organic preparation involving halogenation, nitration, oxidation, reduction, acetylation, benozylation, hydrolysis, diazotization

Reference

1. A. I. Vogel, A Text Book of Practical Organic Chemistry, Longman, 5thEdn., 1989.
2. F. G. Mann and B. C. Saunders, Practical Organic Chemistry, 4thEdn.,Pearson Education, 2009.
3. V. K. Ahluwalia and S. Dhingra, Comprehensive Practical Organic Chemistry, Universities Press, 1stEdn., 2001.

OPEN COURSE IN CHEMISTRY
(FOR STUDENTS OF OTHER PROGRAMMES)
ENVIRONMENTAL SCIENCE

Credits: 4 **72 hrs**

Aim

To study he chemical aspects of environmental issues.

Objectives

To study:

- environmental management and impact assessment
- toxic effects of pollutants
- air, water, and soil pollution

Unit I: Environmental management and impact assessment (5 hrs)

Basic principles, concepts and scope of environmental planningConservation of energy: renewable and non-renewable energy sources-nuclear energy, solar energy, non-conventional energy sources. Environmental pollution: concepts and definition. Impact assessment: aim, concepts and methods, environmental management system: ISO-14001.

Unit II: Chemical toxicology (10 hrs)

Toxicity effects, toxic chemicals in the environment, impact of toxic chemicals on enzymes, biochemical effects of As, Cd, Pb, Hg, Co, NO_x, SO_2 , O_3, PAN, CN, pesticides, carcinogenic substances.

Unit III: Air pollution (10 hrs)

Primary pollutants: hydrocarbons – photochemical, smog, particulates, radioactivity.Effects of atmospheric pollution: acid rain, ozone layer depletion. Indoor air pollution.Effect of electric and magnetic fields in the environment.Air pollution accidents: Bhopal and Chernobyl. Air quality standards.Sampling and analysis of pollutants – CO, SO_2, H_2S, hydrocarbons, SPM. Noise pollution: measurement, classification, hazards.

Unit IV: Water pollution (17 hrs)

Types, effects and sources of water pollution.Pollution of fresh water, ground water and ocean.Thermal pollution. Sampling and measurement of water quality- odour, colour,EC,turbidity,TDS,salinity, COD, BOD, DO, coliform, pH, acidity, CO_2, alkalinity, hardness, NO^{3-}, NO^{2-}, NH3, phosphate, fluoride, chloride, cyanide, sulphide, sulphate and metals- As, Cd, Fe, Pb, Hg,SAR,WQI. Water quality parameters and standard. Case study: Kuttanadu wetland. Waste water treatment techniques.

Unit V: Lithosphere (12 hrs)

Composition of soil - reactions in soil.Wastes and pollutants in soil.Sampling procedures and analysis of soil.Cation exchange capacity, lime status, lime requirement, gypsum requirement, pH, N, P, K, S, Ca, Mg. Management of solid waste.

Reference

1. A. K. De, Environmental Chemistry, New Age International Pvt. Ltd.
2. G. T. Tyler, Living in the Environment, Tomson Brooke/Cole
3. N. Manivasakam, Physico-Chemical Examination of Water, Sewage and Industrial Effluents, Pragathi Prakashan
4. D .Clarson, Soil and Water Analytical Methods, ISBN:81-901483-0-3.
5. R. K. Khitoliya, Environmental Pollution – Management and Control for Sustainable Development, S. Chand & Company Ltd.
6. B. Kebbekus and S. Mitra, Environmental Chemical Analysis, Blacke Academic & Professional
7. S. S.Dara, A Textbook of Environmental Chemistry and Pollution Control, S.Chand & Company Ltd.
8. R. A. Malaviya, Environmental Pollution and its Control under International Law
9. Pramod Singh, Environmental Pollution Management
10. G. K. Ghosh, Environmental Pollution – A Scientific Study
11. Nelson L. Numerow, Industrial Water Pollution
12. James W. Moore and S. Ramamoorthy, Organic Chemicals in Natural Waters
13. Hutzinger, Aquatic Pollutants
14. F. Kreith, Handbook of Solid Waste Management, Mc Graw Hill
15. Standard Methods for Examination of Water and Waste Water, APHA
16. Peter O' Neil, Environmental Chemistry, Blackie Academic and Professional, London
17. S. P. Mishra and S. N. Pandey, Essential Environmental Studies, Ane Books Pvt. Ltd, New Delhi
18. V. K. Ahluwalia, Environmental Chemistry, Ane Books Pvt. Ltd., New Delhi
19. H. D. Kumar, Modern Concepts of Ecology, 8th Edn., Vikas Publishing House Pvt. Ltd., 2006