

BACHELOR OF SCIENCE (HONOURS)

Duration: 36 Months (3 Years) Eligibility: 12th Pass from Science with Minimum 60%

COURSE STRUCTURE OF CHEMISTRY (HONOURS) SEMESTER Ist													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional ***		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks				
Theory Group													
3HBHL101H	Ability Enhancement	fgUnhHkk"kkklajpuk	50	25	08	10	04	15	06	2	-	-	2
3CBCA201H	Ability Enhancement	Basic Information of Computer Technology - I	25	13	04	05	02	07	03	1	-	-	1
3SBCH104H	Core Course - 1	Chemistry -I (Physical Inorganic & Organic Chemistry)	100	50	17	20	08	30	12	4	-	-	4
3SBCH106H	Core Course- 2	POLYMER CHEMISTRY	100	50	17	20	08	30	12	4	-	-	4
	Generic Elective - 1	(Select From Below Given Specialized Subject)*	100	50	17	20	08	30	12	4	-	-	4
Practical Group				Term End Practical Exam		Lab Performance		Sessional					
3SBCH104H	Practical-I	Chemistry -I (Physical Inorganic & Organic Chemistry)	50	25	08	25	08	-	-	-	-	2	2
3SBCH106H	Practical-II	POLYMER CHEMISTRY	50	25	08	25	08	-	-	-	-	2	2
	Practical-III	(Select From Below Given Specialized Subject)*	50	25	08	25	08	-	-	-	-	2	2
3CBCA201H	Practical-IV	Basic Information Computer Technology - I	25	10	04	15	06	-	-	-	-	1	1
Grand Total			550							15	-	07	22

Minimum Passing Marks are equivalent to Grade C

L- Lectures T- Tutorials P- Practical

Major- Term End Theory Exam

Minor- Pre University Test

Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

* Generic Elective Specialization: Opted specialization by student in 1st Semester will remain same in IInd, IIIrd and IVth Semester (See the specialisation subject as mentioned below)*

Generic Elective- 1		
Specialisation	Course Code	Subject
Physics	3SBPH103H	Mechanics, Oscillations and Properties of Matter
Maths	3SBMA105H	Algebra, Trigonometry & Geometry

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Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional ***		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks				
Theory Group													
3HBEL201H	Ability Enhancement	English Language and Indian Culture	50	25	08	10	04	15	06	2	-	-	2
3MBFE101H	Ability Enhancement	Fundamental of Entrepreneurship	50	25	08	10	04	15	06	2	-	-	2
3SBCH204H	Core Course-3	Chemistry –II (Physical Inorganic & Organic Chemistry)	100	50	17	20	08	30	12	4	-	-	4
3SBCH206H	Core Course-4	APPLICATION OF COMPUTERS IN CHEMISTRY	100	50	17	20	08	30	12	4	-	-	4
	Generic Elective -2	(Select From Below Given Specialized Subject)*	100	50	17	20	08	30	12	4	-	-	4
Practical Group				Term End Practical Exam		Lab Performance		Sessional					
3SBCH204H	Practical-I	Chemistry –II (Physical Inorganic & Organic Chemistry)	50	25	08	25	08	-	-	-	-	2	2
3SBCH206H	Practical-II	APPLICATION OF COMPUTERS IN CHEMISTRY	50	25	08	25	08	-	-	-	-	2	2
	Practical-III	(Select From Below Given Specialized Subject)*	50	25	08	25	08	-	-	-	-	2	2
Skill Courses								Sessional					
	Skill Enhancement	Skill Enhancement Elective Course-I	50	-	-	-	-	50	20	1	-	1	2
Grand Total			600							17	-	07	24

Minimum Passing Marks are equivalent to Grade C

Major- Term End Theory / Practical Exam

Minor- Pre University Test

Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

Skill Elective I – Any other course being offered in this semester as per the list given at the end of course structure.

* Generic Elective Specialization: Opted specialization by student in 1st Semester will remain same in IInd, IIIrd and IVth Semester (See the specialisation subject as mentioned below)*

Generic Elective- 2		
Specialisation	Course Code	Subject
Physics	3SBPH203H	Mathematical Background, Electrostatics of Matter
Maths	3SBMA205H	Calculus, Differential Equations& Vector Calculus

L- Lectures T- Tutorials P- Practical

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COURSE STRUCTURE OF CHEMISTRY (HONOURS) SEMESTER IIIrd

Course Details				External Assessment		Internal Assessment				Credit Distribution			Allocated Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional ***		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks				
Theory Group													
3HBHL302H	Ability Enhancement	हिन्दीभाषा सवेधना एतंसंवारसाधन	50	25	08	10	04	15	06	2	-	-	2
3BCA502H	Ability Enhancement	Basic Information of Computer Technology – II	25	13	04	05	02	07	03	1	-	-	1
3SBCH304H	Core Course-5	Chemistry –III (Physical, Inorganic & Organic Chemistry)	100	50	17	20	08	30	12	4	-	-	4
3SBCH306H	Core Course-6	ANALYTICAL METHODS IN CHEMISTRY	100	50	17	20	08	30	12	4	-	-	4
	Generic Elective -3	(Select From Below Given Specialized Subject)*	100	50	17	20	08	30	12	4	-	-	4
Practical Group				Term End Practical Exam		Lab Performance		Sessional					
3SBCH304H	Practical-I	Chemistry –III (Physical, Inorganic & Organic Chemistry)	50	25	08	25	08	-	-	-	-	2	2
3SBCH306H	Practical-II	ANALYTICAL METHODS IN CHEMISTRY	50	25	08	25	08	-	-	-	-	2	2
	Practical-III	(Select From Below Given Specialized Subject)*	50	25	08	25	08	-	-	-	-	2	2
3BCA502H	Practical-IV	Basic Information of Computer Technology – II	25	10	04	15	06	-	-	-	-	1	1
Skill Courses								Sessional					
	Skill Enhancement	Skill Enhancement Elective Course-II	50	-	-	-	-	50	20	1	-	1	2
Grand Total			600							16	-	08	24

Minimum Passing Marks are equivalent to Grade C

Major- Term End Theory / Practical Exam

Minor- Pre University Test

Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

Skill Elective II– Any other course being offered in this semester as per the list given at the end of course structure.

L- Lectures T- Tutorials P- Practical

Generic Elective- 3*

Specialisation	Course Code	Subject
Physics	3SBPH303H	Kinetic Theory of Gases, Thermodynamics and Statistical Mechanics
Maths	3SBMA305H	Calculus, Differential Equation and Mechanics

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COURSE STRUCTURE OF CHEMISTRY (HONOURS) SEMESTER IVth													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional ***		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks				
Theory Group													
3HBEL402H	Ability Enhancement	English language and scientific temper	50	25	08	10	04	15	06	2	-	-	2
3HBHP401H	Ability Enhancement	Human Values & Ethics	50	25	08	10	04	15	06	2	-	-	2
3SBCH404H	Core Course - 7	Chemistry -IV (Physical Inorganic & Organic Chemistry)	100	50	17	20	08	30	12	4	-	-	4
3SBCH406H	Core Course- 8	INDUSTRIAL CHEMICAL & ENVIRONMENT	100	50	17	20	08	30	12	4	-	-	4
	Generic Elective -4	(Select From Below Given Specialized Subject)*	100	50	17	20	08	30	12	4	-	-	4
Practical Group				Term End Practical Exam		Lab Performance		Sessional					
3SBCH404H	Practical	Chemistry -IV (Physical Inorganic & Organic Chemistry)	50	25	08	25	08	-	-	-	-	2	2
3SBCH406H	Practical	INDUSTRIAL CHEMICAL & ENVIRONMENT	50	25	08	25	08	-	-	-	-	2	2
	Practical	(Select From Below Given Specialized Subject)*	50	25	08	25	08	-	-	-	-	2	2
Grand Total			550							16	-	06	22

Minimum Passing Marks are equivalent to Grade C

L- Lectures T- Tutorials P- Practical

Major- Term End Theory Exam

Minor- Pre University Test

Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

Generic Elective- 4*		
Specialisation	Course Code	Subject
Physics	3SBPH403H	Group Waves, Acoustics and Optics
Maths	3SBMA405H	Advanced Calculus, Partial Differential Equations, Complex Analysis and Abstract Algebra

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COURSE STRUCTURE OF CHEMISTRY (HONOURS) SEMESTER Vth													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional ***		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks				
Theory Group													
3SBCH501H	Core Course-9	Coordination Chemistry	100	50	17	20	08	30	12	4	-	-	4
3SBCH502H	Core Course-10	Industrial Chemistry	100	50	17	20	08	30	12	4	-	-	4
3SBCH503H	Core Course-11	Organic Chemistry & Spectroscopy	100	50	17	20	08	30	12	4	-	-	4
*	Discipline Specific Elective-1	Elective table-I	100	50	17	20	08	30	12	4	-	-	4
**	Discipline Specific Elective -2	Elective table-II	100	50	17	20	08	30	12	4	-	-	4
Practical Group				Term End Practical Exam		Lab Performance		Sessional					
3SBCH501H	Practical-I	Core Course-9	50	25	08	25	08	-	-	-	-	2	2
3SBCH502H	Practical-II	Core Course-10	50	25	08	25	08	-	-	-	-	2	2
3SBCH503H	Practical-III	Core Course-11	50	25	08	25	08	-	-	-	-	2	2
3SBCH504H	Practical-IV	Select from Discipline Specific Elective-1	50	25	08	25	08	-	-	-	-	2	2
3SBCH505H	Practical-V	Select from Discipline Specific Elective-2	50	25	08	25	08	-	-	-	-	2	2
***	Skill Enhancement-VI	Skill Enhancement Elective Course-II	50	25		15	10	1	-	1	2	** *	2
Grand Total			800										32

Minimum Passing Marks are equivalent to Grade C

Major- Term End Theory Exam

Minor- Pre University Test

Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

L- Lectures T- Tutorials P- Practical

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COURSE STRUCTURE OF CHEMISTRY (HONOURS) SEMESTER VIth													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional ***		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks				
Theory Group													
3SBCH601H	Core Course-12	Nano-Chemistry	100	50	17	20	08	30	12	4	-	-	4
3SBCH602H	Core Course-13	INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE	100	50	17	20	08	30	12	4	-	-	4
3SBCH603H	Core Course-14	GREEN CHEMISTRY	100	50	17	20	08	30	12	4	-	-	4
***	Discipline Specific Elective	Elective table-III	100	50	17	20	08	30	12	4	-	-	4
****	Discipline Specific Elective//Project/Dissertation	Elective table-IV / Group B DISSERTATION	150	150	40	-	-	-	-	-	-	6	6
Practical Group				Term End Practical Exam		Lab Performance		Sessional					
	Practical-I	Core Course-12	50	25	08	25	08	-	-	-	-	2	2
	Practical-II	Core Course-13	50	25	08	25	08	-	-	-	-	2	2
	Practical-III	Core Course-14	50	25	08	25	08	-	-	-	-	2	2
	Practical-IV	Discipline Specific Elective -3	50	25	08	25	08	-	-	-	-	2	2
Grand Total			750										30

*** If Project/Dissertation not taken then DSE have same marks/credit as other DSE's.**

Minimum Passing Marks are equivalent to Grade C

Major- Term End Theory Exam

Minor- Pre University Test

Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

L- Lectures T- Tutorials P- Practical

DISCIPLINE SPECIFIC ELECTIVE

***Note** - Students need to select any two from below mentioned four papers from Each Group Elective's for Fifth and Sixth semester of **B.Sc. Chemistry (Honours)**.

ELECTIVES FOR SEMESTER 5 TH			ELECTIVES FOR SEMESTER 6 TH		
Course Code	Course Type	List of Electives	Course Code	Course Type	List of Electives
***GROUP ELECTIVE -I			*** GROUP ELECTIVE -III		
3SBCH504H		Bio-Chemistry	3SBCH604H		Chemistry of Natural product
3SBCH505H		Environmental Studies	3SBCH605H		Instrumental Methods of Chemical Analysis
**** GROUP ELECTIVE -II			****GROUP ELECTIVE -IV		
3SBCH506H		Basics of Analytical Chemistry	3SBCH606H		Fundamentals of Spectroscopy
3SBCH507H		Bio molecular Chemistry	3SBCH607H		Some Special aspects of Chemistry

COURSE CODE- 3SBCH608H

Dissertation/Project Guidelines

SKILL ENHANCEMENT ELECTIVE COURSES

Non-Technical			
Elective No.	Department/ Faculty Name		
	Faculty of Information Technology		
I	SCIT 201	Data Entry Operation	2(1+0+1)
II	SCIT 301	Multimedia	2(1+0+1)
III	SCIT 501	Web Designing with HTML	2(1+0+1)
IV	SCMIT 201	Web Development	2(1+0+1)
V	SCMIT 301	LINUX	2(1+0+1)
	Faculty of Management		
I	SMGT 201	Briefing and Presentation Skills	2(1+0+1)
II	SMGT 301	Resolving Conflicts and Negotiation Skills	2(1+0+1)
III	SMGT 802	Entrepreneurship Development	2(1+0+1)
	Faculty of Commerce		
I	SCOM 201	Tally ERP 9	2(1+0+1)
II	SCOM 302	Multimedia	2(1+0+1)
III	SCOM 803	Data Analyst	2(1+0+1)
	Faculty of Humanities		
I	SHBA 301	Pursuing Happiness	2(1+0+1)
II	SHBA302	Communication Skill and Personality Development	2(1+0+1)
III	SHMA301	Tourism in M.P	2(1+0+1)
	Faculty of Science		
I	SSBI 301	Mushroom Cultivation	2(1+0+1)
II	SSPH 301	House Hold Wiring	2(1+0+1)
III	SSPH 301	Basic Instrumentation	2(1+0+1)
IV	SSPH 301	DTP Operator	2(1+0+1)
V	SSCH 301	Graphic Designing	2(1+0+1)
	Faculty of Education		
I	SCBE 403	Understanding of ICTC (Information Communication Technology)	2(1+0+1)
II	SCPE 201	Yoga Education	2(1+0+1)

**BACHELOR OF
SCIENCE
Chemistry (HONOURS)
Syllabus**

Chemistry –I (Physical, Inorganic & Organic Chemistry)

Syllabus

Physical Chemistry

- UNIT - I** **A. *Mathematical Concepts*** : Logarithmic relations, curves stretching, linear graphs and calculation of slopes, Differentiation of functions like Kx , ex , xn , $\sin x$, $\log x$; maxima and minima, partial differentiation and reciprocity relations. Integration of some useful/relevant functions; permutations and combinations. Factorials, Probability.
- B. *Gaseous States*** : Deviation from ideal behavior, van der Waals equation of state. Critical phenomenon : PV isotherms of ideal gases, continuity of states, the isotherms of van der Waals equations, relationship between critical constants and vander Waals constants, the law of corresponding states, reduced equation of states.
- UNIT - II** **A. *Liquid State*** : Intermolecular forces, structure of liquids (a qualitative description) Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholestric phases. Thermography and seven segment cell.
- B. *Colloidal State*** : Definition of colloids, classification of colloids. Solids in liquids (sols): properties- kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number. Liquids in liquids (emulsions) : types of emulsions, preparation. Emulsifier. Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids.
- UNIT - III** ***Chemical Kinetics*** : Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction concentration, temperature, pressure, solvent, light and catalyst. Concentration dependence of rates, mathematical characteristics of simple chemical reactions- zero order, first order, second order, pseudo order, half-life and mean life. Determination of the order of reaction - differential method, method of integration, method of half-life period and isolation method.

Inorganic Chemistry

- UNIT - IV** **A. *Structure and Bonding*** : Hybridizations, Bond lengths and bond angles, bond energy : Localized and delocalized chemical bond, van-der Waals interactions, inclusion compounds, clatherates, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.
- B. *Mechanism of Organic reactions*** : Curved arrow notations, drawing electron movements with arrows, half-headed and double headed arrows, homolytic and heterolytic bond breaking.
- C. *Types of Reagents*** : *Electrophiles* and nucleophiles. Types of organic reactions. Energy consideration. Reactive intermediates- carbocations, carbanions, free radicals and carbenes. Methods of determination of reaction mechanism.

Organic Chemistry

- UNIT - V** ***Stereochemistry***: Concept of isomerism, types of isomerism, optical isomerism, elements of symmetry, molecular chirality, enantiomers, stereogenic centres, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, mesocompounds, resolution of enantiomers, inversion, retention and

racemization. Relative and absolute configurations, sequence rule, D & L, R & S systems of nomenclature. E and Z system of Nomenclature geometrical isomerism in alicyclic compounds. Conformation, conformational analysis of ethane and n-butane. Conformations of cyclohexanes, axial and equatorial bonds, Newman projection and Sawhorse formulae, Fischer and Flying wedge formulae.

PRACTICAL

A. (Any one experiment will be asked in examination form the following carrying 12 Marks)

1. Calibration of thermometer
2. Determination of melting point
3. Determination of boiling point
4. Determination of mixed melting point
5. Preparation of solutions of various concentrations, NaOH, HCl, H₂SO₄.

B. (Any one experiment will be asked in examination form the following carrying 12 Marks)

1. To determine the velocity constant (specific reaction rate) of hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
2. To study the effect of acid strength on the hydrolysis of an ester.
3. To compare the strength of HCl and H₂SO₄ by studying the kinetics of hydrolysis of ester.
4. To study kinetically the reaction rate of decomposition of iodide by H₂O₂.
5. Determination of surface tension / percentage composition of given organic mixture using surface tension method.
6. Determination of viscosity / percentage composition of given organic mixture using viscosity method.

C. (Any one experiment will be asked in examination form the following carrying 12 Marks)

1. Distillation
2. Crystallization
3. Decolourisation and crystallization using charcoal
4. Sublimation

Viva: 6 marks

Reference Books

- J.D. Lee, Huheey, Keiter, Keiter, Cotton, Atkins and also Puri, Sharma, Kalia.
- Morrison & Boyd, Solomons and Fryhle, I.L. Finar
- Chemistry, Bahl, Arun & Bahl B.S., S Chand Publications
- Chemistry for Degree Students (B.Sc. Elective Semester- V/VI - Elective-II) (As per CBCS) Madan R.L., S., S Chand Publications
- Text Book Of Chemistry, Pragati Prakashan
- Text Book Of Chemistry, Ram Prasad & Sons

POLYMER CHEMISTRY

Syllabus

UNIT I *Introduction and history of polymeric materials*: Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Functionality and its importance: Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.

UNIT II *Kinetics of Polymerization*: Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and crystallinity: Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

UNIT III *Nature and structure of polymers-Structure Property relationships*. Determination of molecular weight of polymers (M_n , M_w , etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance.

Polydispersity index. Glass transition temperature (T_g) and determination of T_g , Free volume theory, WLF equation, Factors affecting glass transition temperature (T_g).

UNIT IV *Polymer Solution* – Criteria for polymer solubility, Solubility parameter, Thermodynamics Of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers Solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures. Properties of Polymers (Physical, thermal, Flow & Mechanical Properties). Brief introduction to preparation, structure, properties and application of the following

UNIT V *Polymers: polyolefins*, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide polypyrrole, polythiophene)].

PRACTICAL

(Any one experiment will be asked in examination form the following)

A. Polymer synthesis

- Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
 - Purification of monomer
 - Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutyronitrile (AIBN)

B. Preparation of nylon 66/6

- Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
 - Preparation of IPC

- b. Purification of IPC
- c. Interfacial polymerization

C. Redox polymerization of acrylamide

- 1. Precipitation polymerization of acrylonitrile
- 2. Preparation of urea-formaldehyde resin
- 3. Preparations of novalac resin/resold resin.
- 4. Microscale Emulsion Polymerization of Poly(methylacrylate).

D. Polymer characterization

- 1. Determination of molecular weight by viscometry:
 - (a) Polyacrylamide-aq. NaNO₂ solution
 - (b) (Poly vinyl propylidene (PVP) in water
- 2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of “head-to-head” monomer linkages in the polymer.
- 3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
- 4. Testing of mechanical properties of polymers.
- 5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

- 1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
 - 2. Instrumental Techniques
 - 3. IR studies of polymers
 - 4. DSC analysis of polymers
 - 5. Preparation of polyacrylamide and its electrophoresis
- *at least 7 experiments to be carried out.

Reference Books:

- Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
 - Harry R. Allcock, Frederick W. Lampe and James E. Mark, Contemporary Polymer Chemistry, 3rd ed. Prentice-Hall (2003)
 - Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)
 - Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)
 - PetrMunk and Tejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons (2002)
 - L. H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)
 - Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005)
 - Seymour/ Carraher’s Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013)

 - Seymour’s Polymer Chemistry, Marcel Dekker, Inc.
 - G. Odian: Principles of Polymerization, John Wiley.
 - F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
 - P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
 - R.W. Lenz: Organic Chemistry of Synthetic High Polymers.
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Chemistry-II (Physical, Inorganic & Organic Chemistry)

Syllabus

Inorganic Chemistry

UNIT I A. Atomic Structure : Idea of de Broglie's matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrödinger wave equation, significance of quantum numbers, radial and angular wave functions and probability distribution curves, effective nuclear charge.

B. Periodic Properties: Atomic and ionic radii, ionization energy, electron affinity and electronegativity : definition, method of determination, trends in periodic table and applications.

C. Chemical Bonding : Covalent bond- valence bond theory and its limitations, directional characteristic of covalent bond. Hybridization and shapes of simple molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory to NH_3 , SF_4 , ClF_3 , ICl_2^- and H_2O .

UNIT II A. S-Block Elements: Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, an introduction to alkyls and aryls.

B.p-Block Elements: Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of groups 13-16. Hydrides of boron-diborane and higher boranes. Borazine, borohydrides. Fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetranitride, basic properties of halogens, interhalogens.

Physical Chemistry

UNIT III A. Molecular Orbital theory for homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and the bond energy, % ionic character from dipole moment and electronegativity difference. Weak interactions, hydrogen bonding, van der Waals forces.

B. Ionic Solids : Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, Lattice defects, semiconductors, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability of ions. Fajan's rule, Metallic bond, free electron, Valence bond and Band theories.

Organic Chemistry

UNIT IV A. Arenes and Aromaticity: Nomenclature of benzene derivatives. The aryl group, Aromatic nucleus and side chain structure of benzene, molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure. MO picture. Aromaticity the Huckel rule, aromatic ions. Aromatic electrophilic substitution, Mechanism of nitration, halogenation, sulphonation, and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituents. orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. Methods of formation and chemical reactions of alkylbenzenes and biphenyl.

B. Alkenes : Nomenclature of alkenes, methods of formation, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regio-selectivity in alcohol dehydration. The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes, mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration-oxidation, oxymercuration-reduction, Epoxidation, ozonolysis.

UNIT V A. Cycloalkenes, Dienes and alkynes : Methods of formation, conformation and chemical reactions of cycloalkenes, nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions - 1,2 and 1,4 additions, Diels-Alder reaction. Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and

nucleophilic addition reactions, hydroborationoxidation and polymerization.

B. Alkyl and Aryl Halides : Nomenclature and classes of alkyl halides, methods of formation, chemical reactions; mechanisms of nucleophilic substitution reaction of alkyl halides, SN2 and SN1 reactions with energy profile diagrams.

Practical

Max. Marks 50

A

1. Inorganic mixture analysis
2. Macro/Semi-micro Analysis- Cation analysis, separation and identification of ions from
3. group I-VI, anion analysis
4. Separation of cations by paper chromatography. **4 marks**
5. Preparation of ferrous alum. **8 marks**

B

1. Detection of elements (N, S and halogens) 2 elements, **4 marks**
2. Functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and aniline) in simple organic compounds.

C. functional groups: 8 marks

Viva: 6 marks

Records: 8 marks

APPLICATION OF COMPUTERS IN CHEMISTRY

COURSE CODE: 3SBCH206H

(Core Course -IV)

Syllabus

UNIT I *Basics*: Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

UNIT II *Numerical methods*: Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi.

UNIT III *Differential calculus*: Numerical differentiation.

UNIT IV *Integral calculus*: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values. *Simultaneous equations*: Matrix manipulation: addition, multiplication. Gauss-Siedal method. *Interpolation, extrapolation and curve fitting*: Handling of experimental data.

UNIT V *Conceptual background of molecular modeling*: Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods.

Practicals

Computer programs based on numerical methods for :

1. Roots of equations: (e.g. volume of van der Waals gas and comparison with ideal gas, pH of a weak acid).
2. Numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).
3. Numerical integration (e.g. entropy/ enthalpy change from heat capacity data), probability distributions (gas kinetic theory) and mean values.
4. Matrix operations. Application of Gauss-Siedel method in colourimetry.
5. Simple exercises using molecular visualization software.

Reference Books:

- McQuarrie, D. A. *Mathematics for Physical Chemistry* University Science Books(2008).
- Mortimer, R. *Mathematics for Physical Chemistry*. 3rd Ed. Elsevier (2005).
- Steiner, E. *The Chemical Maths Book* Oxford University Press (1996).
- Yates, P. *Chemical Calculations*. 2nd Ed. CRC Press (2007).
- Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
- Noggle, J. H. *Physical Chemistry on a Microcomputer*. Little Brown & Co. (1985).
- Venit, S.M. *Programming in BASIC: Problem solving with structure and style*. Jaico Publishing House: Delhi (1996).

Chemistry-III (Physical, Inorganic & Organic Chemistry)

Syllabus

Physical Chemistry

UNIT I Thermodynamics-I: Definition of thermodynamic terms: System, surrounding, Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work.

First Law of Thermodynamics: Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's Law: Joule Thomson coefficient and inversion temperature. Calculation of w , q , dU and dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. Thermochemistry: Standard state, standard enthalpy of formation: Hess's Law of heat summation and its application. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermochemical data, temperature dependence of enthalpy, Kirchoff's equation.

Second Law of Thermodynamics: Need for the law, different statements of the law, Carnot cycle and its efficiency. Carnot theorem. Thermodynamic scale of temperature.

UNIT II Thermodynamics-II (a) Concept of entropy: Entropy as a state function, entropy as a function of P&T, entropy change in physical change, Clausius inequality, entropy as criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Third Law of Thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data, Gibbs and Helmholtz functions, Gibbs function (G) and Helmholtz function(A) as a thermodynamic quantities, A and G as a criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of G and A with P, V and T.

Inorganic Chemistry

UNIT III Chemistry of elements of I transition series: Characteristic properties of d-block elements. Properties of the elements of the first transition series, their binary compounds such as carbides, oxides and sulphides. Complexes illustrating relative stability of their oxidation states, coordination number and geometry chemistry of elements of II and III transition series: General characteristics, comparative treatment with their 3d-analogues in respect of ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry

UNIT IV (a) Coordination Compounds: Werner's coordination theory and its experimental verification, EAN Concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, VBT of transition metal complexes.

(b) Oxidation and Reduction: Use of redox potential data, analysis of redox cycle, redox stability in H₂O: Frost, Latimer and Pourbaix diagram. Principles involved in the extraction of elements.

Organic Chemistry

UNIT V (a) Alcohols: Classification and nomenclature. Monohydric alcohols: nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding, acidic nature, reactions of alcohols. Dihydric alcohols: nomenclature, methods of formation, chemical reactions of vicinal glycols, pinacole-pinacolone rearrangement. Trihydric alcohols-nomenclature and methods of formation, chemical reactions of glycerol.

(b) Phenols: Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols: resonance stabilization of

phenoxide ion. Reactions of phenols: electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis and Riemeier-Tiemann reaction

(c)Ethers and Epoxides: Nomenclature of ethers and methods of their formation, physical properties. Chemical reactions: cleavage and auto oxidation. Ziesel's method. Synthesis of epoxides. Acid and base-catalysed ring opening of epoxides, orientation of epoxide ring opening, reaction of Grignard and organolithium reagents with epoxides.

PRACTICALS:

Time: 6 hours

Inorganic Chemistry 18 marks

1. Calibration of the fractional weights, pipettes and burettes.
2. Preparation of standard solutions. Dilution of 0.1 M to 0.001 M solutions.

Quantitative analysis ; Volumetric analysis.

1. Determination of acetic acid in commercial vinegar using NaOH.
2. Determination of alkali content- antacid tablet using HCl.
3. Estimation of calcium content in chalk as calcium oxalate by permanganometry.
4. Estimation of hardness of water by EDTA

Gravimetric analysis: Analysis of Barium as barium sulphate.

Organic Chemistry ; Laboratory Techniques

A. Thin layer chromatography

Determination of R_f values and identification of organic compounds.

1. Separation of green leaf pigments (spinach leaves may be used).
2. Preparation and separation of 2,4-dinitrophenylhydrazones of acetone, 2-butanone, hexane-2 and 3-one using toluene and light petroleum (40:6)
3. Separation of a mixture of dyes using cyclohexane and ethylacetate (8:5:1.5). B. Paper chromatography: Ascending and Circular Determination of R_f values and identification of organic compounds
4. Separation of a mixture of phenylalanine and glycine, alanine and aspartic acid, leucine and glutamic acid. Spray reagent ninhydrin.
5. Separation of a mixture of DL-alanine, glycine and L-leucine using n-butanol: acetic acid: water (4:1:5). Spray reagent ninhydrin.
6. Separation of monosaccharides- a mixture of D-galactose and D-fructose using n-butanol: acetone: water (4:1:5). Spray reagent-aniline hydrogen phthalate.

Reference Books

- Inorganic Chemistry, B.R. Puri (Author), L.R. Sharma
- Principles of Inorganic Chemistry, B.R. Puri, L.R. Sharma, K.C. Kalia
- Principles of Physical Chemistry, B. R. Puri, Madan S. Pathania, L. R. Sharma
- Unified Chemistry, Pragati Prakashan
- Inorganic Chemistry, Pearson: Principles of Structure and Reactivity

ANALYTICAL METHODS IN CHEMISTRY

COURSE CODE: 3SBCH306H

(Core course-6)

Syllabus

UNIT I Qualitative and quantitative aspects of analysis: Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their Expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

UNIT II 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;

UNIT III Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

UNIT IV Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotopesubstitution.

UNIT V Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

PRACTICALS

I. Separation Techniques; Chromatography

- (a) Separation of mixtures
 - (i) Paper chromatographic separation of Fe^{3+} , Al^{3+} , and Cr^{3+} .
 - (ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the R_f values.
- (b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their R_f values.
- (c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC

II. Solvent Extractions:

1. To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+} -DMG complex in chloroform, and determine its concentration by spectrophotometry.
2. Solvent extraction of zirconium with amberlite LA-1, separation from a mixture of iron and gallium.
3. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
4. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
5. Analysis of soil:
 - (i) Determination of pH of soil.
 - (ii) Total soluble salt
 - (iii) Estimation of calcium, magnesium, phosphate, nitrate
6. Ion exchange:

- (i) Determination of exchange capacity of cation exchange resins and anion exchange resins.
- (ii) Separation of metal ions from their binary mixture.
- (iii) Separation of amino acids from organic acids by ion exchange chromatography.

III Spectrophotometry

1. Determination of pKa values of indicator using spectrophotometry.
- 2 Structural characterization of compounds by infrared spectroscopy.
- 3 Determination of dissolved oxygen in water.
- 4 Determination of chemical oxygen demand (COD).
- 5 Determination of Biological oxygen demand (BOD).
- 6 Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

Reference Books

- Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.
- Willard, H.H. *et al.: Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
- Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
- Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
- Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
- Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & Allied Methods*, Elsevier Harwood Ltd. London.
- Ditts, R.V. *Analytical Chemistry: Methods of separation*. Van Nostrand, New York, 1974.

Chemistry-IV (Physical, Inorganic & Organic Chemistry)

Syllabus

Physical Chemistry

UNIT I Phase equilibrium: Statement and the meaning of the terms: phase component and the degree of freedom, derivation of the Gibbs phase rule. Phase equilibria of one component system: water, CO₂ and S system. Phase equilibria of two component system: solid liquid equilibria, simple eutectic: Bi-Cd, Pb-Ag system, desilverisation of lead.

Solid solutions: compound formation with congruent melting point (Mg-Zn) and incongruent melting point, (NaCl-H₂O) (FeCl₃-H₂O) and (CuSO₄-H₂O) system. Freezing mixtures, acetone-dry ice. Liquid-liquid mixtures: Ideal liquid mixtures, Raoult's and Henry's law. Non-ideal system azeotropes: HCl-H₂O and ethanol water systems.

UNIT II Electrochemistry: Electrical transport- conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of specific conductance and equivalent conductance with dilution.

Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number: Application of conductivity measurements: determination of degree of dissociation, determination of K_a of acids, determination of solubility product of sparingly soluble salt, conductometric titrations.

Definition of pH and pK, determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods.

Inorganic Chemistry

UNIT III (a) Chemistry of Lanthanides Elements: electronic structure, oxidation states, ionic radii and lanthanide contraction, complex formation, occurrence and isolation of lanthanide compounds.

(b) Chemistry of Actinides: General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, Similarities between the later actinides and later lanthanides

(c) Acids and Bases: Arrhenius, Bronsted-Lowry, Lux-Flood, Solvent system and Lewis concepts of acids and bases.

(d) Non-aqueous Solvents: Types of solvents and their general characteristics, reaction in non-aqueous solvents with reference to liquid NH₃ and liquid SO₂

Organic Chemistry

UNIT IV (a) Aldehydes and ketones: Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes and ketones. Physical properties. Mechanism of nucleophilic additions to carbonyl group aldolperkin and knovenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction. Clemmensen, Wolf-Kishner, LiAlH₄ and NaBH₄ reductions.

(b) Carboxylic Acids: Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids, reactions of carboxylic acids. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Methods of formation and chemical reactions of unsaturated monocarboxylic acids.

UNIT V Organic Compounds of Nitrogen: Preparation of nitroalkanes and nitroarenes. Chemical reaction of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid. Halonitroarenes: reactivity, structure and nomenclature. Structure and nomenclature of amines, physical properties and stereochemistry of amines. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Amine salt as phase transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel-Phthalamide reaction, Hoffmann bromamide reaction, Reactions of amines, electrophilic aromatic substitution in aryl amines, reaction of amines with nitrous acid. Synthetic transformation of aryl diazonium salts, azo coupling.

PRACTICALS:

Time: 6 hours

Organic Chemistry 12 marks

Qualitative analysis

Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

Physical Chemistry 12 marks

Transition temperature

1. Determination of transition temperature of given substance by thermometric, dilatometric method (e.g.) ($\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$ / $\text{SrBr}_2 \cdot 2\text{H}_2\text{O}$).

Phase equilibrium

1. To study the effect of solute (e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquid (e.g., phenol water system) and to determine the concentration of that soluble in phenol water system.
2. To construct the phase diagram of two component (e.g., diphenylamine benzophenone) by cooling curve method.

Thermochemistry

1. To determine the enthalpy of neutralization of weak acid/weak base versus strong acid/ strong base and determine the enthalpy of ionization of the weak acid/ base.

Inorganic chemistry-Quantitative Volumetric Analysis

1. Estimation of ferrous and ferric by dichromate method.
2. Estimation of copper using thiosulphate.

Viva 6 Marks

Sessional 8 Marks

Reference Book

- Inorganic Chemistry, B.R. Puri (Author), L.R. Sharma
- Principles of Inorganic Chemistry, B.R. Puri, L.R. Sharma, K.C. Kalia
- Principles of Physical Chemistry, B. R. Puri, Madan S. Pathania, L. R. Sharma
- Unified Chemistry, Pragati Prakashan
- Inorganic Chemistry, Pearson: Principles of Structure and Reactivity

INDUSTRIAL CHEMICAL & ENVIRONMENT

Syllabus

UNIT I *Industrial Gases and Inorganic Chemicals**Industrial Gases:* Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

UNIT II *Inorganic Chemicals*: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

UNIT III *Industrial Metallurgy* Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology. Introduction to Non-Ferrous Metal Extraction- General Principles of Extraction of Metals from Oxides and Sulphides- Mineral Resources of Non-ferrous Metals in India. Extraction of Cu in Pyrometallurgical Process, Extraction of Zn in Pyrometallurgical Process, Extraction of Pb in Pyrometallurgical Process, Extraction of Ni in Pyrometallurgical Process, Extraction of Mg in Pyrometallurgical Process, Extraction of Al in Pyrometallurgical Process, Extraction of Zr, Extraction of Ti, Extraction of Sn, Extraction of Nb, Extraction of U.

UNIT IV *Environment and its segments**Ecosystems* Biogeochemical cycles of carbon, nitrogen and sulphur. Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution. Pollution by SO₂, CO₂, CO, NO_x, H₂S and other foul smelling gases. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates. *Water Pollution:* Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

UNIT V *Energy & Environment**Sources of energy:*

Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc. Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management. Biocatalysis Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Practical

Determination of dissolved oxygen in water.

1. Determination of Chemical Oxygen Demand (COD)
2. Determination of Biological Oxygen Demand (BOD)
3. Percentage of available chlorine in bleaching powder.
4. Measurement of chloride, sulphate and salinity of water samples by simple titration
5. Method (AgNO₃ and potassium chromate). Estimation of total alkalinity of water samples (CO₃)²⁻, H(CO₃)³⁻ using double titration method.
6. Measurement of dissolved CO₂.
7. Study of some of the common bio-indicators of pollution.
8. Estimation of SPM in air samples.
9. Preparation of borax/ boric acid.

Reference Books:

- E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
- S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
- K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi
- G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
- A. Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).

Coordination Chemistry

COURSE CODE: 3SBCH501H
(Core course-9)

Syllabus

UNIT I *Bioinorganic Chemistry - I* Essential and trace elements in biological processes, metalloporphyrins with special reference to haemoglobin and myoglobin, Biological role of alkali and alkaline earth metal ions with special reference to Ca^{2+} . Nitrogen fixation.

Bioinorganic Chemistry - II Role of metal ions in biological process, Na/K pump, metal complexes as therapeutic agents anticancer agents, antiarthritits drugs and chelation therapy.

Hard and Soft Acids and Bases (HSAB)- Classification of acids and bases as hard and soft, Pearson's HSAB concept, acid-base strength and hardness and softness, Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness.

Gravimetric Analysis Principles of gravimetric estimation, supersaturation, co-precipitation, post-precipitation and Ash treatment with respect to the estimation of Ba, Zn and Cu.

Water Analysis- Hardness, types of hardness-Temporary, permanent and total hardness, acidity and alkalinity, BOD, COD and DO.

UNIT II *Organometallic compounds*; Organomagnesium compounds-the Grignard reagents-formation, structure and synthetic applications, organozinc compounds, formation and chemical reactions, Organolithium compounds-formation and chemical reactions. Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti. A brief account of metal-ethylenic complexes and homogeneous hydrogenation; mononuclear carbonyls and the nature of bonding in metal carbonyls. Transition metal organometallic compounds with bonds to hydrogen and boron. Metal nitrosyls: modes of coordination, nature of bonding and probable applications.

Inorganic polymers Introduction and scope of inorganic polymers, special characteristics, classification, homo and hetero atomic polymers and their applications. Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.

UNIT III *Chemistry of elements of I transition series*: Characteristic properties of d-block elements. Properties of the elements of the first transition series, their binary compounds such as carbides, oxides and sulphides. Complexes illustrating relative stability of their oxidation states, coordination number and geometry chemistry of elements of II and III transition series: General characteristics, comparative treatment with their 3d-analogues in respect of ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry

UNIT IV(a) *Coordination Compounds*: Werner's coordination theory and its experimental verification, EAN Concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, VBT of transition metal complexes.

(b) Oxidation and Reduction: Use of redox potential data, analysis of redox cycle, redox stability in H_2O : Frost, Latimer and Pourbaix diagram. Principles involved in the extraction of elements.

UNIT V (a) *Chemistry of Lanthanides Elements*: electronic structure, oxidation states, ionic radii and lanthanide contraction, complex formation, occurrence and isolation of lanthanide compounds.

(b) *Chemistry of Actinides*: General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, Similarities between the later actinides and later lanthanides.

(c) *Acids and Bases*: Arrhenius, Brønsted-Lowry, Lux-Flood, Solvent system and Lewis concepts of acids and bases.

(d) *Non-aqueous Solvents*: Types of solvents and their general characteristics, reaction in non-aqueous solvents with reference to liquid NH₃ and liquid SO₂

PRACTICAL

A. (Complex Compound Preparation)

1. Diaquabis(methyl acetoacetato)nickel(II)
2. Diaquabis(ethyl acetoacetato)cobalt(II)
3. Bis(methyl acetoacetato)copper(II) monohydrate
4. Potassium chlorochromate(IV)
5. Tetraamminecopper(II) sulphate monohydrate
6. Mercury(II) tetrathiocyanatocobaltate(II)
7. Hexaamminenickel(II) chloride

B. Analysis of inorganic mixture containing five radicals with at least one interfering radical (phosphate, borate, oxalate or fluoride).

C. Calibration of the fractional weights, pipettes and burettes. Preparation of standard solutions. Dilution of 0.1 M to 0.001 M solutions.

Quantitative analysis - Volumetric analysis.

- (a) Determination of acetic acid in commercial vinegar using NaOH.
- (b) Determination of alkali content- antacid tablet using HCl.
- (c) Estimation of calcium content in chalk as calcium oxalate by permanganometry.
- (d) Estimation of hardness of water by EDTA

Gravimetric analysis: Barium as barium sulphate

Reference Books

- Concise Coordination Chemistry by R Gopalan and V Ramalingam
- Coordination Chemistry by K Sarn
- Coordination Chemistry by Pimplapure and Jain
- Coordination Chemistry by Ajai Kumar
- Coordination Chemistry (Structure and Bonding) by N W Alcock and T K Chandrashekar
- Physical Inorganic Chemistry: A Coordination Chemistry Approach by S F A Kettle

Industrial Chemistry

COURSE CODE: 3SBCH502H
(Core course-10)

Syllabus

UNIT I *Distillation Introduction,*

batch and continuous distillation, separation of azeotropes, plate columns and packed columns.

Absorption: Introduction, equipments, packed columns, spray columns, bubble columns, mechanically agitated contactors.

UNIT II *Evaporation Introduction,*

equipments, short tube evaporator, forced circulation evaporators, falling film evaporators, wiped (agitated) film evaporators.

Filtration:

Introduction, equipments, plate and frame filter press, Nutch filter, rotary drum filter, sparkler filter, candle filter, Bag filter.

UNIT III *Energy Balance*

Heat capacity of pure gases and gaseous mixtures at constant pressures, sensible heat changes in liquids, Enthalpy changes.

Drying: Introduction, free moisture, bound moisture, drying curve, equipments– tray dryer, rotary dryer, flash dryer, fluid bed dryer, drum dryer, spray dryer.

UNIT IV *Catalysis Introduction,*

Types, Basic principles, mechanisms, factors affecting the performance, introduction to phase transfer catalysis, Enzymes catalyzed reactions- rate model, industrially important reactions.

Renewable Natural resources: Cellulose, Starch: - properties, modification, important industrial chemicals derived from them. Alcohols, oxalic acid and Furfura.

UNIT V *Utilities in Industry Fuel Types of fuels –*

advantages and disadvantages.

Boilers: Types of boilers and their functioning.

Water: Specifications for Industrial use, various water treatments. **Steam:** Generation and use.

Fluid Flow: Fans, Blowers, Compressors, vacuum pumps, Ejectors.

Pumps: Reciprocating pumps, Gear pumps, Centrifugal pumps.

Heat Transfer: Heat exchangers- shell and tube type, finned tube heat exchangers, plate heat exchangers, refrigeration cycles.

CHEMISTRY PRACTICAL

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO_3 and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-} , HCO_3^-) using double titration method.
7. Measurement of dissolved CO_2 .
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.

- S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, NewDelhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, NewDelhi.

COURSE CODE: 3SBCH503H
(Core course-11)

Organic Chemistry & Spectroscopy

Syllabus

UNIT I *Spectroscopy – I*

(a) Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom.

(b) Rotational spectrum of diatomic molecules. Energy levels of a rigid rotator (semi classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution), determination of bond length, qualitative description of non-rigid rotator, isotope effect.

(c) *Raman spectrum*, concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules, application of Raman spectrum.

Spectroscopy - II

(d) *UV Spectroscopy* : Electronic excitation, elementary idea of instrument used, Applications to structure determination of organic molecules. Woodward-Fieser rule for determining max of , - unsaturated carbonyl compounds.

(e) *Infrared Spectrum* : Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups.

UNIT II *Spectroscopy – II(Organic Analysis)*

Electromagnetic Spectrum: Absorption Spectra; UV absorption spectroscopy: Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones. IR absorption spectroscopy; molecular vibrations, Hook's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

UNIT III *Alcohols:* Classification and nomenclature. Monohydric alcohols: nomenclature, methods of formation by reduction of Aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding, acidic nature, reactions of alcohols. Dihydric alcohols: nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [Pb(OAc)₄ and HIO₄] and pinacole-pinacolone rearrangement. Trihydric alcohols-nomenclature and methods of formation, chemical reactions of glycerol

Phenols: Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols: resonance stabilization of phenoxide ion. Reactions of phenols: electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, Lederer-Manasse reaction and Riemer-Tiemann reaction

UNIT IV *Aldehydes and ketones:* Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes and ketones from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acids. Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldolperkin and knovenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction. Meerwein-Ponndorf-Verley (MPV), Clemmensen, Wolf-Kishner, LiAlH₄ and NaBH₄ reductions, Halogenation of enolizable ketones. An introduction of alpha, beta unsaturated aldehydes and ketones

Carboxylic Acids: Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids, reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Carboxylic acid derivatives Structure and nomenclature of acid chlorides, esters, amides (urea) and acid anhydrides. Physical properties, Preparation of carboxylic acid derivatives, chemical reactions. Mechanism of esterification and hydrolysis (acidic and basic).

UNIT V (a) *Ethers and Epoxides* Nomenclature of ethers and methods of their formation, physical properties. Chemical reactions: cleavage and auto oxidation. Ziesel's method. Synthesis of epoxides. Acid and base-catalysed ring opening of epoxides, orientation of epoxide ring opening, reaction of Grignard and organolithium reagents with epoxides.

(b) *Organosulphur compounds* Nomenclature, structural features, method of formation and chemical reactions of thiols, thioethers, sulphonic acids, sulphonamides and sulphaguanidine.

(c) *Amino acids Classification*, structure, stereochemistry of amino acids, acid base behaviour, isoelectric point, general methods of preparation and properties of α -amino acids

(d) *Proteins and peptides* Introduction to peptides linkage, synthesis and end group analysis of peptides, solid phase synthesis, classification, properties and structure of proteins (primary, secondary and tertiary).

(e) *Organic Compounds of Nitrogen Preparation of nitroalkanes and nitroarenes*. Chemical reaction of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid.

Practical Organic Chemistry

(Qualitative analysis)

- Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.
- Binary mixture analysis containing two solids: Separation, identification and preparation of derivatives.

(Organic Chemistry Preparation)

- Acetylation
- Benzoylation
- meta-Dinitrobenzene
- Picric acid

Reference Books

- Textbook of Organic Chemistry, Rakesh K. Parashar, V.K. Ahluwalia
- Advanced Organic Chemistry, I Francis A. Carey, Richard A. Sundberg
- Advanced Organic Chemistry, II Francis A. Carey, Richard A. Sundberg
- Physical Inorganic Chemistry: A Coordination Chemistry Approach by S F A Kettle
- Inorganic Chemistry, B.R. Puri (Author), L.R. Sharma
- Principles of Inorganic Chemistry, B.R. Puri, L.R. Sharma, K.C. Kalia
- Principles of Physical Chemistry, B. R. Puri, Madan S. Pathania, L. R. Sharma

***GROUP ELECTIVE -I
3SBCH504H (DSE)

Biochemistry

Syllabus

Unit I Introduction to Biochemistry, Water as a biological solvent. Carbohydrates: Structure, occurrence and biological importance of monosaccharides and disaccharides Stereoisomerism and optical isomerism of sugars. Ring structure, epimers, anomers and mutarotation. Important reactions of sugars. Important derivatives of monosaccharides. Structure, occurrence and biological importance of oligosaccharides and polysaccharides. e.g. Cellulose, glycogen and starch, chitin, agar. Mucopolysaccharides.

Unit II Fatty acids, Classification, structure and properties of saturated and unsaturated fatty acids. Essential fatty acids. Triacylglycerols, properties and characterization of fats – hydrolysis, saponification, halogenation, Acetyl number, Rancidity of fats, Reichert-Meissel number. Reaction of glycerol. Glycerophospholipids (lecithins, cephalins, phosphatidyl serine, phosphatidyl inositol, plasmalogens), sphingomyelins, glycolipids- cerebrosides, sulfolipids, gangliosides. Cholesterol and Bile acids.

Unit III Amino acids, Structure and classification of amino acids, stereoisomerism, zwitter ion in aqueous solutions, physical and chemical properties, titration of amino acids, Isoelectric pH, Essential amino acids. Peptides: Peptide bond, Determination of the amino acid sequence of a polypeptide chain, chemical and enzymatic cleavage of a polypeptide chains and separation of peptides. Classification of proteins, behaviour of proteins in solutions, salting in and salting out of proteins, Denaturation and renaturation of proteins.

Unit IV Protein structure, Levels of structure in protein architecture, primary structure of proteins, secondary structure of proteins – helix and pleated sheets, tertiary structure of proteins, forces and bonds stabilizing the structure proteins. Structure of fibrous proteins (keratins and collagen), globular proteins (hemoglobin and myoglobin). Composition of DNA and RNA. Features of DNA double helix. Denaturation and annealing of DNA, Secondary and tertiary structure of DNA, Watson Crick model, A, B and Z type of DNA. Different types of RNA and their role, Secondary and tertiary structure of RNA.

Unit V Important Metalloporphyrins occurring in nature, Bile pigments- chemical nature and their physiological significance. Hormones: Structure and biological functions of Insulin, Glucagon, Epinephrine, Thyroxine, Structure, properties and role of fat soluble and water soluble vitamins, Coenzyme functions of vitamins.

Practicals

1. Preparations of Different biochemical reagents

a. Ninhydrin Reagent , b. Benedicts Reagent , c. Barfoeds Reagent ,d. Biuret Reagent

2. Qualitative test for amino acid

a. Ninhydrin test for amino acid , b. Millions test c. Sakaguchi test

3. Qualitative test for protein.

a. Precipitation with organic solvent , b. Precipitation with TCA , c. Precipitation with Ammonias sulphate

4. Qualitative test for carbohydrate

a. Molish test b. Iodine test , c. Benedicts test, d. Barfoeds test ,e. Osazone formation

5. Qualitative test for Nucleic acid

a. Orcinol test b. Diphenyl amine test, c. Neumann's test

6. Qualitative test for lipid

a. Iodine test ,b. saponification test, c. emulsification

7. Qualitative Test for Vitamin-

a) Thiamine b) Ascorbic Acid c) Riboflavine

Reference Books

- T.G. Cooper: Tool of Biochemistry.
- Keith Wilson and John Walker: Practical Biochemistry.
- Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
- Thomas M. Devlin: Textbook of Biochemistry.
- Jeremy M. Berg, John L Tymoczko, Lubert Stryer: Biochemistry.

- G. P. Talwar and M Srivastava: Textbook of Biochemistry and Human Biology.
- A.L. Lehninger: Biochemistry.
- O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods.
- Biochemistry : U. Satyanarayana
- Biochemistry :LubestStryer
- Textbook of Biochemistry : Jain & Jain
- An Introduction to practical Biochemistry : David Plummer (TMH)
- Hawke's Physiological Chemistry
- Laboratory Manual in Biochemistry : J. Jayaraman

***GROUP ELECTIVE -I
3SBCH505H(DSE)

Environmental Studies

Syllabus

UNIT-I Introduction to environmental sciences: NATURAL RESOURCES : Environmental Sciences
 - Relevance - Significance - Public awareness - Forest resources - Water resources - Mineral resources
 - Food resources - conflicts over resource sharing - Exploitation - Land use pattern - Environmental impact - fertilizer - Pesticide Problems - case studies.

UNIT-II Ecosystem, biodiversity and its conservation: Ecosystem - concept - structure and function - producers, consumers and decomposers - Food chain - Food web - Ecological pyramids - Energy flow
 - Forest, Grassland, desert and aquatic ecosystem. Biodiversity - Definition - genetic, species and ecosystem diversity - Values and uses of biodiversity - biodiversity at global, national (India) and

local levels - Hotspots, threats to biodiversity - conservation of biodiversity - Insitu&Exsitu.

UNIT-III Environmental pollution and management Environmental Pollution - Causes - Effects and control measures of Air, Water, Marine, soil, solid waste, Thermal, Nuclear pollution and Disaster Management - Floods, Earth quake, Cyclone and Landslides. Role of individuals in prevention of pollution - pollution case studies.

UNIT-IV Social issues - human population Urban issues - Energy - water conservation - Environmental Ethics - Global warming - Resettlement and Rehabilitation issues - Environmental legislations - Environmental protection Act. 1986 - Air, Water, Wildlife and forest conservation Act - Population growth and Explosion - Human rights and Value Education - Environmental Health - HIV/AIDS - Role of IT in Environment and Human Health - Women and child welfare - Public awareness - Case studies.

UNIT-V Field Work Visit to a local area / local polluted site / local simple ecosystem - Report submission

Practical

Field Study

Exercise – 1 Study of a simple ecosystem (Suggested habitats: pond, river, estuarine, grassland, forest and desert) and description of the biotic and abiotic components of the ecosystem.

Exercise - 2 Study of effects of human interaction with natural environment.

Exercise - 3 Survey of vegetation, birds, insects and other animals in an area.

Exercise - 4 Choose five common species of Trees / plants from your NEIGHBORHOOD and list their common names. Describe each plant in terms of its height and leaves.

Exercise - 5 Describe the environmental problem of your locality and suggest a remedy.

Exercise - 6 Identifying the sources of pollution in water obtained from different sources.

Exercise - 7 To segregate domestic waste into bio-degradable and non-biodegradable components.
3. Lab Exercise

Exercise - 8 To study the quality of a sample of water collected or provided.

Exercise - 9 To determine Texture of various soil samples.

Exercise - 10 To estimate the amount dust (particulate matter) deposition on the leaves of roadside plants.

Exercise - 11 To Study the effect of light intensity on the growth of plants. 4. Creative Exercise

Exercise - 12 To set up an aquarium.

Exercise - 13 To study the biodiversity of birds and insects in your locality.

Exercise - 14 To prepare a list of plants and animals which are used for making meals at home on any one day and to comment on the habit and habitat of each.

Exercise - 15 To make a herbarium sheet.

Exercise - 16 To describe : a) climate of an urban area; b) yearly variation in suspended particulate matter in the same area.

Exercise - 17 To Make an audit of the electrical energy consumption by various household appliances.

Reference Books

- Kumarasamy, K., A.Alagappa Moses AndM.Vasanthy, 2004. Environmental Studies, Bharathidsan University Pub, 1, Trichy
- Rajamannar, 2004, Environemntal Studies, Evr College Pub, Trichy
- Kalavathy,S. (Ed.) 2004, Environmental Studies, Bishop Heber College PUB., TRICHY

*****GROUP ELECTIVE -II
3SBCH506H**

Basics of Analytical Chemistry

Syllabus

UNIT I Errors and treatment of Analytical Chemistry Errors, Determinant, constant and indeterminate. Accuracy and precision Distribution of random errors. Average derivation and standard derivation, variance and confidance limit. Significance figures and computation rules.Least square method.

UNIT II Chromatographic methods: General principle, classification of chromatographic methods. Nature of partition forces.Chromatographic behavior of solutes.Column efficiency and resolution.Gas Chromatography: detector, optimization of experimental conditions. Ion exchanges chromatography. Thin layer chromatography: coating of materials, prepative TLC. Solvents used and methods of detection Column chromatography. Adsorption and partition methods.Nature of column materials.Preparation of the column.Solvent systems and detection methods.

UNIT III ElectroanalyticalTechniques Polarography: Introduction, Instrumentation, Ilkovic equation and its verification. Derivation of wave equation, Determination of half wave

potential, qualitative and quantitative applications. Amperometry: Basic principles, instrumentation, nature of titration curves, and analytical applications.

UNIT IV Theory of Volumetric and Gravimetric Analysis Standard solutions Indicators, theory of indicators, types of titrations, Acid, base, precipitation, Redox and complexometric titrations, Acid–base titrations in nonaqueous media, solvent characterisation, leveling effect, applications of non-aqueous titrations.

UNIT V Computer Science: Introduction: History etc. Hardware: Central processor unit. Input devices. Storage devices. Peripherals, Software: Overview of the key elements of basic program structure, loops, arrays, mathematical function. User defined functions, conditional statements, string. Applications. Data representation.

Practicals

- 1. Error analysis & Statistical data analysis,** Error, types of errors, minimization of errors, statistical treatment for error analysis standard deviation, Relative standard, Linear Least Squares.
Calibration of Volumetric apparatus, burettes, pipettes, standard flask, weight box etc.
- 2. Volumetric analysis,** Basic principles. Determination of iodine and saponification values of oil sample Determination of DO, COD, BOD, Hardness of water samples.
- 3. Gravimetric analysis,** Determination of metal ions eg. Ni, Cu etc. by gravimetric methods using organic precipitants such as dimethylglyoxime, 8-hydroxyquinoline, etc.
- 4. Chromatography :-**
Separation of cations and anions by-
(a) Paper chromatography (b) Column Chromatography
- 5. pHmetry / potentiometry :** Determination of strength of acids etc.
- 6. Flame Photometry / AAS/ FIA/ Colorimetry :-**
Determination of cations/anions and metal ions, e.g. Na^+ , K^+ , Ca^{2+} , SO_4^{2-} , NO_2^- , Fe, Mo, Ni, Cu, Zn, etc.
- 7. Spectrophotometry :-**
Verification of Beer-Lambert Law. Molar absorptivity calculation, plotting graph to obtain ϵ_{max} etc. Effect of pH in aqueous coloured systems. Determination of metal ions, e.g. Fe, Cu, Zn, Pb, etc. using inorganic reagent like SCN and organic chelating agent like dithizone, cupferron 8-hydroxyquinoline, etc. in aqueous/organic phase in the presence of surface active agents.
- 8. Nephelometry / Turbidimetry :-**
Determination of chloride, sulphate, phosphate, turbidity, etc.

Reference Books

- Analytical Chemistry: (J.W) G. D. Christain
- Introduction to chromatography : Bobbit
- Instrumental Methods of analysis (CBS)- H.H . Willard, L.L. Mirrit, J.A. Dean
- Instrumental Methods of Analysis : Chatwal and Anand
- Instrumental Methods of Inorganic Analysis(ELBS) : A.I. Vogel
- Chemical Instrumentation: A Systematic approach- H.A. Strobel
- The principals of ion-selective electrodes and membrane transport: W.E.Morf

- Physical Chemistry – P.W.Atkins
- Principal of Instrumental Analysis- D. Skoog and D.West
- Treatise on Analytical Chemistry: Vol I to VII – I.M. Kolthoff
- Computer, Fundamentals-P.K.Sinha
- Programming in BASIC : E. Balaguruswamy

***GROUP ELECTIVE -II
3SBCH507H(DSE)

Bio-molecular Chemistry

Syllabus

Unit I Nucleic Acids-Components of nucleic acids, Nucleosides and nucleotides Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine Structure of polynucleotides.

Unit II Amino Acids, Peptides and Proteins-Amino acids, Peptides and their classification. α -Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis .

Unit III Enzymes- Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

Unit IV Lipids -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.

Unit V Pharmaceutical Compounds- Structure and Importance 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).

Practicals – Bio-molecular Lab

1. Estimation of glycine by Sorenson's formalin method.
2. Study of the titration curve of glycine.
3. Estimation of proteins by Lowry's method.
4. Study of the action of salivary amylase on starch at optimum conditions.
5. Effect of temperature on the action of salivary amylase.
6. Saponification value of an oil or a fat.
7. Determination of Iodine number of an oil/ fat.
8. Isolation and characterization of DNA from onion/ cauliflower/peas.

Recommended Books

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
- Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.

COURSE CODE: 3SBCH601H
(Core course-12)

Nano-Chemistry

Syllabus

Unit I Background to Nanoscience Definition of Nano, Scientific revolution-Atomic Structure and atomic size, Emergence and challenges of nanoscience and nanotechnology Carbon age-new form of carbon (CNT to Graphene), Size effects and crystals Large surface to volume ration, surface effects on the properties

Unit II Synthesis of Nanomaterial's, Top-down and bottom up approach, Solution chemical methods, Sol-gel processing
Template self-assembly, Spin coating, Gas or vapor based methods of synthesis: CVD, MOCVD and MB, Ball Milling

Unit III Structural Characterization Techniques of Nanomaterials, Diffraction analyses: X-ray diffraction, powder diffraction, Lattice parameters, Structure analyses, strain analyses Phase identification, particle size analyses using -Scherer's formula, Surface Imaging: Scanning Electron Microscope (SEM, Field Emission Scanning Electron Microscope (FESEM), Transmission Electron Microscopy (TEM)

Unit IV Mechanical Processing and Properties of Nanomaterials, Processing of Powders of Metals and Ceramics, Metal/Ceramic Powder synthesis, Compacting and

Sintering, Production of Porous and Dense Composite Components, Advanced Composite materials, Structure-Property Relationship

Unit V Applications of Nanomaterials, Nanomaterials in Health Care and Agriculture, Nanomaterials in Energy Conversion and Storage, Nanomaterials in textile, self-cleaning, self-healing, Nanomaterials in Sensors

Practical

1. Synthesis of nanomaterials by combustion method, sol-gel route, co-precipitation technique, hydrothermal method and template assisted route
2. Preparation of porous materials and nano-composites
3. Structural Characterization of synthesized nanomaterials by X-ray Powder Diffraction Method, calculation of particle size and strain using Scherrer formula
4. Characterization of synthesized nanomaterials by SEM, FESEM and TEM

Reference Books

- C. N. R. Rao, A. Muller, A. K. Cheetham (Eds), **The chemistry of nanomaterials: Synthesis, properties and applications**, Wiley VCH Verlag GmbH & Co, Weinheim, 2004.
- G. Cao, **Nanostructures and Nanomaterials: Synthesis, properties and applications**, Imperial College Press, 2004.
- G.A. Ozin, C. Andre, and L. Arsenault, Cademartiri, **Nanochemistry: A chemical Approach to Nanomaterials**, Royal Society of Chemistry, 2005.
- T. Pradeep, **NANO: The Essentials**, Tata-McGraw Hill, New Delhi, 2007.
- K.J. Klabunde, **Nanoscale Materials in Chemistry**, Wiley-Interscience, 2001.
- G. Schmidt, **Nanoparticles: From theory to applications**, Wiley Weinheim 2004.
- □ Fahan, **Materials Chemistry**, Springer (2004).

COURSE CODE: 3SBCH602H
(Core course 13)

INORGANIC MATERIALS OF INDUSTRIAL IMPORTANCE

Syllabus

Unit I Silicate Industries

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

Unit II Fertilizers: Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.\

Unit III Surface Coatings: Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-

friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

Unit IV Batteries: Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

Alloys; Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Unit V Catalysis: General principles and properties of catalysts, homogenous catalysis (catalytic steps and examples) and heterogenous catalysis (catalytic steps and examples) and their industrial applications, Deactivation or regeneration of catalysts. Phase transfer catalysts, application of zeolites as catalysts.

Chemical explosives: Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite (RDX). Introduction to rocket propellants.

PRACTICAL

1. Determination of free acidity in ammonium sulphate fertilizer.
2. Estimation of Calcium in Calcium ammonium nitrate fertilizer.
3. Estimation of phosphoric acid in superphosphate fertilizer.
4. Electroless metallic coatings on ceramic and plastic material.
5. Determination of composition of dolomite (by complexometric titration).
6. Analysis of (Cu, Ni); (Cu, Zn) in alloy or synthetic samples.
7. Analysis of Cement.
8. Preparation of pigment (zinc oxide).

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics*, Wiley Publishers, New Delhi.
- J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- P. C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry*, Vikas Publications, New Delhi.
- B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut

COURSE CODE: 3SBCH603H
(Core course 14)

GREEN CHEMISTRY

Syllabus

UNIT – I *Introduction to Green Chemistry* What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

UNIT –II *Principles of Green Chemistry and Designing a Chemical synthesis* Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

UNIT – III *Examples of Green Synthesis* Reactions Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to Strecker synthesis), citral, ibuprofen, paracetamol, furfural. Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzoic acid), Oxidation (of toluene, alcohols) Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation.

UNIT – IV Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2-dihydrotriazine derivatives; benzimidazoles. Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizzaro reaction, Strecker synthesis, Reformatsky reaction. Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of “Clayan”, a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.

UNIT – V Future Trends in Green Chemistry Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development.

PRACTICAL

1. Safer starting materials

The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch.

Effect of concentration on clock reaction

Effect of temperature on clock reaction. (if possible)

2. Using renewable resources

Preparation of biodiesel from vegetable oil.

3. Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

(I) Triethylamine ion + OH⁻ → propene + trimethylpropene + water



(II) 1-propanol + water →

The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

4. Use of enzymes as catalysts - Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide

Alternative Green solvents

5. Diels Alder reaction in water - Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux.

6. Extraction of D-limonene from orange peel using liquid CO₂ prepared from dry ice.

7. Mechanochemical solvent free synthesis of azomethines

8. Co-crystal controlled solid state synthesis (C²S³) of N-organophthalimide using phthalic anhydride and 3-aminobenzoic acid.

Alternative sources of energy

9. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).

10. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books

- Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice*, Oxford University Press(1998).
- Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC(2002).
- Ryan, M.A. *Introduction to Green Chemistry*, Tinnensand; (Ed), American Chemical Society, Washington DC(2002).
- Sharma, R.K.; Sidhwani, I.T. &Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN 978-93-81141-55-7 (2013).
- Cann,M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society(2008).
- Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry*, American Chemical Society(2008).
- Pavia, D. L. Lamponan, G. H. &Kriz, G.S. *W B Introduction to organiclaboratory*
- V.K. Ahluwalia& M.R. Kidwai: *New Trends in Green Chemistry*, Anamalaya Publishers (2005).
- P.T. Anastas& J.K. Warner: *Oxford Green Chemistry- Theory and Practical*, University Press (1998).
- A.S. Matlack: *Introduction to Green Chemistry*, Marcel Dekker (2001).
- M.C. Cann& M.E. Connely: *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
- M.A. Ryan & M. Tinnensand, *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).

Chemistry of Natural product

Syllabus

UNIT I Terpenoids (10+2) Structure and synthesis of abietic acid, zingiberene, santonin,

UNIT II Alkaloids Structure, stereochemistry, synthesis and biosynthesis of the following Structure of morphine, reserpine, ephedrine, (+) Conin.

UNIT III a) Steroids Occurrence, nomenclature, basic skeleton, Diels hydrocarbon and study of the following hormones, Androsterone, Testosterone, Estrone, Progesterone, Aldosterone and cartisone. Biosynthesis of steroids.

b) Prostaglandins Occurrence, nomenclature, classification, biogenesis and physiological effects,

UNIT IV Biogenesis , Alkaloids (pyridine, morphine and indole type) terpenoids of classes with examples, cholesterol, flavones, coumarins, carbohydrates and proteins. Chemistry of Protein Hormones: Insulin, Oxytocin, Thyroxin and Anti-thyroid drugs

UNIT V Vitamins Synthesis and structure of biotin and vitamin B2, synthesis of vitamin B1, biological functions of B6, B12, folic acid and thiamin.

Practical

- Isolation and characterization of the following natural products:
- Piperine from black pepper
- Hesperidin from orange peel.
- Strychnine from Nux vomica seeds.
- Curcumin from turmeric powder.
- Lycopene from tomatoes.
- Myristicin and trimyristicin from nutmeg.
- Tannic acid from myrobalan.
- Isolation of casein from milk.
- Lysozyme from albumen.
- Extraction and estimation of carvone from caraway seeds.
- Separation of natural products through column chromatography.

Degradation and characterization of degradation products of a) Piperine b) Atropine and c) Caffeine. Any other relevant experiments based on theory.

REFERENCE BOOKS

- Burger's Medicinal Chemistry, M.E. – Wolff, Ed., John Wiley & Sons, New York.
- R. M. Acheson, An Introduction to the Chemistry of Heterocyclic Compounds, Interscience NY
- Organic Chemistry, Vol.II by I.L. Finar, The English Language Book Society, London.
- Natural Products Vol.I& II by O.P. AgarwalGoel publications – Meerut.
- F.G.Mann& B. Saunders, Practical Organic Chemistry Longmans Green & Co. Ltd., U.K

INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

Syllabus

UNIT I Infrared spectroscopy: Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.

UV-Visible/ Near IR – emission, absorption, fluorescence and photoacoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and Double Beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoacoustic, fluorescent tags). (16 Hours)

UNIT II Separation techniques Chromatography: Gas chromatography, liquid chromatography, supercritical fluids, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis.

UNIT III Immunoassays and DNA techniques Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation).

UNIT IV Elemental analysis: Mass spectrometry (electrical discharges). Atomic spectroscopy: Atomic absorption, Atomic emission, and Atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), Wavelength separation and resolution (dependence on technique), Detection of radiation (simultaneous/scanning, signal noise), Interpretation (errors due to molecular and ionic species, matrix effects, other interferences).

UNIT V NMR spectroscopy: Principle, Instrumentation, Factors affecting chemical shift, Spincoupling, Applications.

PRACTICALS

- Safety Practices in the Chemistry Laboratory
- Determination of the isoelectric pH of a protein.
- Titration curve of an amino acid.
- Determination of the void volume of a gel filtration column.
- Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
- Quantitative Analysis of Mixtures by Gas Chromatography (i.e., chloroform and carbon tetrachloride)
- Separation of Carbohydrates by HPLC
- Potentiometric Titration of a Chloride-Iodide Mixture
- Cyclic Voltammetry of the Ferrocyanide/Ferricyanide Couple
- Use of fluorescence to do “presumptive tests” to identify blood or other body fluids.

- Use of “presumptive tests” for anthrax or cocaine
- Collection, preservation, and control of blood evidence being used for DNA testing
- Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA chromosome only or multiple chromosome)
- Use of sequencing for the analysis of mitochondrial DNA
- Laboratory analysis to confirm anthrax or cocaine
- Detection in the field and confirmation in the laboratory of flammable accelerants or explosives
- Detection of illegal drugs or steroids in athletes
- Detection of pollutants or illegal dumping
- Fibre analysis

(At least 10 experiments to be performed.)

Reference Books:

- Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
- Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.
- Instrumental methods of Chemical Analysis, G.W. Ewing, 5th Edition, McGraw-Hill, New York, 1988.
- Principles of Instrumental Analysis, Skoog, D.A, S.J. Holler, T.A. Nilman, 5th Edn., Saunders college publishing, London, 1998.
- Instrumental Methods of Chemical Analysis, Chatwal Anand, 3rd Edition, Himalaya Publishing House, 1986.
- Principles of Electroanalytical Methods, T. Riley and C. Tomilinson, John Wiley and Sons, 2008.
- Instrumental Methods of Chemical Analysis, K. Sharma, Goel Publishing House Meerut 2000.

Fundamentals of Spectroscopy

Syllabus

UNIT I Ultraviolet Spectroscopy- Woodward- Fisher rules for conjugated dienes and carbonyl compounds; Calculation of max. Ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

UNIT II IR Spectroscopy Characteristic vibrational frequencies of alkanes; alkenes; alkynes; aromatic compounds; alcohols; ethers; phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds [ketones; aldehydes; esters; amides; acids; anhydrides; lactones; lactams and conjugated carbonyl compounds] Effect of hydrogen bonding and solvent effect on vibrational frequencies; overtones; combination bands and Fermi resonance.

UNIT III NMR Spectroscopy General introduction and definition; chemical shift; spin –spin interaction; shielding mechanism of measurement; chemical shift values and correlation for protons bonded to carbons [aliphatic; olefinic; aldehydic and aromatic] and other nuclei [alcohols; phenols; enols; acids; amines; amides and mercapto]; chemical exchange; effect of deuteration; complex spin-spin interaction, virtual coupling. Karplus curve variation of coupling constant with dihedral angle. shift reagent; solvent effect. nuclear overhauser effect [NOE] Resonance of other nuclei – F; P.

UNIT IV Mass Spectrometry Introduction, Different types of ion, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement, nitrogen rule. High-resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

UNIT V a) Carbon-13 NMR Spectroscopy General considerations; chemical shift [aliphatic; olefinic; alkyne; aromatic; heteroaromatic and carbonyl compounds]; problems associated with ¹³C, FT-NMR, proton decoupled off resonance.

b) Structural problems based on combined spectroscopic techniques.

PRACTICALS

1. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
2. Nuclear Magnetic Resonance
3. Determination of Caffeine in Beverages by HPLC
4. IR Absorption Spectra (Study of Aldehydes and Ketones)
5. Determination of Calcium, Iron, and Copper in Food by Atomic Absorption
6. Mass spectral fragmentation of organic compounds
7. chemical shift (determination)

REFERENCE BOOKS

- V.M. Parikh, Application spectroscopy of organic molecules. (Mehata)
- D.W. Williams and Flemming, Spectroscopic methods of organic compound.
- Silverstein and Basallar, Spectroscopic identification of organic compounds V.M.
- Parikh ORPTION SPECTROSCOPY OF ORGANIC MOLECULES (J. Wiley)
- P.S. Kalsi Spectroscopy of organic compounds (New age publisher)
- J.R. Dyer. Application of absorption spectroscopy of organic compounds.
- Jackman and Sterneil , Application of NMR spectroscopy
- J.D. Roberts, Nuclear magnetic resonance (J. Wiley)

- Jafee and Orchin, Theory and application of U.V,
- K. Benjamin. Mass spectroscopy
- Beynon J H et.al , The mass spectra of organic molecules.
- Wehli F.W, Marchand A. P. Interpretation of carbon 13 NMR (J. Wiley)
- W. Kemp, Organic spectroscopy ELBS
- Willard Merritt and Dean. Instrumental methods of analysis CBS
- Das and Jame , Mass Spectroscopy.
- Group Theory by Cotton& Wilkinson.

Some Special aspects of Chemistry

Syllabus

Unit I Symmetry and Group Theory in Chemistry-Symmetry elements and symmetry operation, definition of a group, subgroup, relation between orders of a finite group and its subgroup. Point symmetry group. Character table and their use.

UNIT II Green Chemistry: Introduction and importance of green chemistry? Principles of green chemistry. Green alternative solvents and reagents in organic synthesis. Recent advances in green synthetic methodologies.

UNIT III Chemical Toxicology: Toxic chemicals in the environment, biochemical effects of arsenic, cadmium, lead, mercury, carbon dioxide, chloro-fluorocarbons, pesticides. Chemical and bio-warfare agents. Environmental and public health.

UNIT IV Separation Techniques: Liquid-liquid solvent extraction, super critical fluid extraction. Theory of chromatography, terminology used in chromatography, high performance liquid chromatography, gas chromatography and size exclusion chromatography.

UNIT V Chemistry of some Typical Natural Products: A study of the following compounds involving their isolation, structure elucidation and synthesis: Alkaloids- Hofmann exhaustive methylation, nicotine; Terpenes- Isoprene rule, citral, flavonoids quercetin.

Practical

1. Paper chromatographic separation of metal ions (binary mixture only)
2. Colorimetric determination of metal ions.
3. Solvent extraction separation and estimation of Mg (ii) and Fe(ii)
4. Ion exchange Method- Separation and estimation of Mg (ii) and Zn(ii) v. EDTA titrations of Ca^{2+} , Mg^{2+} , Zn^{2+} and Cu^{+2} vi. Determination of hardness of water by EDTA.
5. Paper chromatographic separation of amino acids and sugars (only binary mixtures)
6. Determination of acid value of a vegetable oil.
7. Determination of iodine value of a vegetable oil.
8. Determination of saponification value of vegetable oil.
9. Hydrolysis of methyl acetate catalyses by an acid.
10. Hydrolysis of Ethylacetate.
11. Extraction of caffeine from tea leaves.
12. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.

Reference Books

- Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
- Arthur, I. V. Quantitative Organic Analysis, Pearson.
- Vogel, A.I. Quantitative Organic Analysis, Part 3, Pearson (2012).
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
- Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore. • Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
- Ditts, R.V. Analytical Chemistry – Methods of separation.
- Instrumental Methods of Analysis”, H. H. Willard, L. L. Merritt, and J. A. Dean, 6th Edition (1986), CBS Publishers & Distributors, Shahdara, Delhi.
- Organic Chemistry”, I. L. Finar, [Vol. 2, 6th Edition (1973), Reprinted in 1980 & Vol. II, 5th Edition (1975), Reprinted in 1996], ELBS and Longman Ltd., New Delhi.
- Basic Concepts of Analytical Chemistry”, S. M. Khopkar, 2nd Edition (1998), New Age International Publications, New Delhi.

Dissertation/Project

Guidelines

DISCIPLINE SPECIFIC ELECTIVE

***Note** - Students need to select any two from below mentioned four papers from Each Group Elective's for Fifth and Sixth semester of **B.Sc. Chemistry (Honours)**.

ELECTIVES FOR SEMESTER 5 TH			ELECTIVES FOR SEMESTER 6 TH		
Course Code	Course Type	List of Electives	Course Code	Course Type	List of Electives
***GROUP ELECTIVE -I			*** GROUP ELECTIVE -III		
3SBCH504H		Bio-Chemistry	3SBCH604H		Chemistry of Natural product
3SBCH505H		Environmental Studies	3SBCH605H		Instrumental Methods of Chemical Analysis
**** GROUP ELECTIVE -II			****GROUP ELECTIVE -IV		
3SBCH506H		Basics of Analytical Chemistry	3SBCH606H		Fundamentals of Spectroscopy
3SBCH507H		Bio molecular Chemistry	3SBCH607H		Some Special aspects of Chemistry