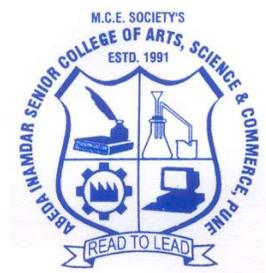


**Abeda Inamdar Senior College of Arts, Science and
Commerce, Pune 411001**

(Autonomous)

Affiliated to Savitribai Phule Pune University



Syllabus for

M. Sc. Part-I

(M.Sc. Analytical Chemistry and M.Sc. Organic Chemistry)

Choice Based Credit System [CBCS]

From Academic Year 2021-22

Board of Studies (Chemistry)

Post Graduate Department of Chemistry and Research Center

**Abeda Inamdar Senior College of Arts, Science and Commerce,
Pune-411001.**

Syllabus of Autonomous M. Sc. Part-I Chemistry
Choice Based Credit System [CBCS]
[2021-22]

Structure of the Course:

Basic Frame work of the syllabus for M. Sc. Part-I leading to M.Sc. Analytical Chemistry and M. Sc. Organic Chemistry at the Abeda Inamdar Senior College of Arts, Science and Commerce, (Autonomous), Pune affiliated to Savitribai Phule Pune University.

Sr. No.	Paper No.	Subject	Credit
SEMESTER-I			
1	21SMCH111	CHP-111: Kinetics and Thermodynamics in Chemistry	4
2	21SMCH112	CHI-112: Symmetry, Group Theory and Main Group Chemistry	4
3	21SMCH113	CHO-113: Basic Organic Chemistry and Stereochemistry	4
		(Any One from Following CHA-114)	
4	21SMCH114A	CHA-114A: Biochemistry	2
4	21SMCH114B	CHA-114B: Material Science	2
5	21SMCH115	CHP-115: Physical Chemistry Practical-I	2
6	21SMCH116	CHI-116: Inorganic Chemistry Practical-I	2
7	21SMCH117	CHO-117: Organic Chemistry Practical-I	2
SEMESTER-II			
8	21SMCH121	CHP-121: Molecular Spectroscopy, Chemical Bonding and Nuclear Chemistry	4
9	21SMCH122	CHI-122: Co-ordination and Bio-inorganic Chemistry	4
10	21SMCH123	CHO-123: Synthetic Organic Chemistry and Spectroscopy	4
		(Any One from Following CHA-124)	
11	21SMCH124A	CHA-124A: Advanced Analytical Chemistry	2
11	21SMCH124B	CHA-124B: Organometallic Chemistry	2
12	21SMCH125	CHP-125: Physical Chemistry Practical-II	2
13	21SMCH126	CHI-126: Inorganic Chemistry Practical-II	2
14	21SMCH127	CHO-127: Organic Chemistry Practical-II	2

- *N.B.:** 1. One Credit Theory Paper = 15 Hours lectures per semester and 1 Hour per week.
 2. Two Credit Practical Paper = 60 Hours practical per semester and 4 hours per week.
 3. Each semester has extra Non-CGPA credit course as mention in PG examination handbook.

M. Sc. Programme Objectives and Outcomes

Programme Objectives:

1. To develop conscience towards social responsibility, human values and sustainable development through curriculum delivery and extra-curricular activities
2. To develop scientific temperament with strong fundamental knowledge of the subject
3. To develop analytical thinking and problem-solving skills needed for various entrance and competitive examinations and Post Graduate Studies
4. To train students in laboratory skills and handling equipment along with soft skills needed for placement
5. To mold a generation of youth which can apply the chemistry in their life and careers?
6. To inculcate scientific attitude enriched with a multidisciplinary perspective in the students.
7. To update the students with the needs of the industry and society with respect to chemistry.

Programme Outcomes: After completing the M. Sc. Programme, the students shall:

1. Know the basics and applied aspects of the chemistry.
2. Be in a position to apply their knowledge in their professional, social and personal life.
3. Be competent to pursue research or a career in the chemistry.
4. Have the knowledge and confidence to pursue higher studies in Chemistry
5. Have skills in laboratory techniques and experience in instrument handling
6. Develop sensitivity towards social issues and become productive citizens of the nation.

Programme Specific Outcome:

A) M.Sc. Analytical Chemistry:

1. The student should know fundamental aspects and the potential uses of Analytical Chemistry from industrial point of view.
2. Apply appropriate analytical techniques for the qualitative and quantitative analysis of chemicals in laboratories and industries as well.

3. Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects and limitations.
4. The student should be able operate advanced analytical technique such as HPLC, Column Chromatography, GC, Coulometry, CV, Solvent Extraction.
5. To interpret the data obtained from techniques like TGA/DTA, XRD, SEM, TEM and the Spectroscopic techniques.
6. Should be able to synthesize and characterize nano particles and nano materials.
7. Should learn about the uses of analytical instruments in industrial chemistry, medicinal chemistry and green chemistry.
8. Should develop accuracy and precision in performing experiments. Should understand the different types of errors and methods for minimizing errors.

B) M.Sc. Organic Chemistry:

1. Should gain knowledge in basic organic chemistry, re-arrangements, modern synthetic reagents, coupling reaction, multicomponent synthesis and click chemistry reactions.
2. Students should be able to gain knowledge in classical organic laboratory techniques and the uses of modern instrumentation to perform new experiments.
3. Should be able to understand Advanced Spectroscopic Techniques, Stereochemistry, Organic Synthesis and basics of Computer Aided Drug Designing as well.
4. Should acquire the ability to synthesize, separate and characterize compounds using laboratory and instrumentation techniques.
5. Should be able to integrate the knowledge learned in Organic Chemistry to various industrial and pharmaceutical needs.
6. Learn about the potential uses of retro-synthetic analysis, medicinal chemistry, natural products chemistry and green chemistry.
7. Should be able to shoulder responsibilities in R & D labs.
8. To interpret the data obtained from various spectral techniques, through theoretical principals.
9. Able to apply knowledge of organic chemistry in research problems.
10. Should know about global level research opportunities to pursue Ph.D. programmes, targeted approach of CSIR – NET and other competitive examinations.

11. Should know enormous job opportunities at all levels of chemical, pharmaceutical, food products, life-oriented material industries.

• **Evaluation Pattern:**

For each Theory and Practical Course, 50-50 pattern will be followed. Internal assessment will be of 50 marks for a paper of 100 Marks. Internal assessment will be of 25 marks for a paper of 50 Marks.

For Continuous Internal Evaluation (CIE), evaluation of theory courses will be done continuously. The 50 marks of Internal Evaluation shall be divided into the following:

- a) One Mid Semester Exams of 15 Marks each.
- b) Two Class Tests of 15 marks each converted to 15 Marks.
- c) One Presentation/Seminar/MCQ Test of 5 Marks.
- d) One Group Discussion/Open Book Test of 5 or 10 Marks.
- e) Class Assignments of 10 or 5 Marks.
- f) A compulsory Mock Practical Examination and Viva Voce of practical subjects.
- g) Internal marks for Journal / project report/ dissertation report completion and certification.

The student has to obtain 40% marks in the combined examination of In-semester assessment and Semester-End assessment with a minimum passing of 40% in both these separately.



M. C. E. Society's

Abeda Inamdar Senior College

Of Arts, Science and Commerce, Camp, Pune-1

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

M. Sc. Part-I

SEMESER-I

Course/ Paper Title	CHP-111- Kinetics and Thermodynamics in Chemistry
Course Code	21SMCH111
Semester	I
No. of Credits	4 Credits, (48 L, 12T)

Aims & Objectives of the Course

Sr. No.	Objectives
	Students should;
1.	Understand and interpret the principles of physical and chemical observations.
2.	Be able to explain the proposed hypotheses in terms of fundamental concepts.
3.	Solve numerical problems through application of formulae.
4.	Apply logic and reasoning to theoretical and conceptual arguments in Physical Chemistry.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
	Student should be able to;
1.	Understand the thermodynamic properties of ideal and real gases and absolute entropy of a system. Also, they should be able to derive expressions of colligative properties of solution based on chemical potential and its applications to real systems.
2.	Analyze the probability distributions of a system among the energy levels using principles of statistical thermodynamics. Also, they should be able to derive expressions for probability distribution of particles among the various energy levels according to Boltzmann, Bose-Einstein and Fermi-Dirac statistics.
3.	Explain the rate of chemical reactions and should be able to solve

	numerical problems.
4.	Determine order and rate law of a chemical change based on experimental data.
5.	Calculate the rate constants of parallel and opposing reactions and derive the rate expressions of chain reactions for the formation of hydrogen halides by applying steady-state approximation.
6.	Explain the kinetics of fast reactions using various instrumentation techniques.
7.	Use the Arrhenius equation to calculate a rate constant, activation energy, and frequency factor.
8.	Collision Theory at the molecular level, activation energy and relationship of reaction rate with temperature.
9.	Explain role of enzymes as biological catalysts and their specificity and rate of reactions.

Section-I: Thermodynamics

Unit No.	Title with Contents	No. of Lectures
I	Thermodynamics: State function, path function, exact differential and inexact differential, internal energy and enthalpy, temperature dependent internal energy, enthalpy, reversible and irreversible adiabatic expansion. Entropy of irreversible changes, Helmholtz and Gibbs function, Entropy and Entropy change in an ideal gas with temperature and pressure, Clausius inequality, chemical potential, chemical potential of a substance in a mixture, Problems.	08
II	Change of State: Partial molar quantities, methods for determination of molar quantities, ideal solutions, Raoult's and Henry's law, Thermodynamics of mixing, colligative properties: Derivations of colligative properties based on chemical potential, Elevation in boiling point, depression in freezing point and osmosis, problems.	10
III	Molecular Thermodynamics: Molecular energy levels, Boltzmann distribution law, partition functions	06

	and ensembles, translational, rotational and vibrational partition function of diatomic molecule, obtaining energy, heat capacity, entropy and equilibrium constants from partition functions, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics, problems.	
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References Books:

1. Physical Chemistry by P. W. Atkins and De Paul
2. Physical Chemistry by T. Engel and P. Reid
3. Physical Chemistry for Biological Sciences by Raymond Chang (Universal books, 2000)
4. Physical Chemistry by Merron and C.F. Prouton
5. Physical Chemistry by G.M. Barrow

Section-II: Chemical Kinetics and Reaction Dynamics

Unit No.	Title with Contents	No. of Lectures
I	Rate Laws and Complex reactions: Recapitulations of basic concept, the temperature dependent reaction rates, Kinetics of fractional order reaction, Kinetics of nth order reaction, reaction moving towards equilibrium, consecutive reaction, parallel reactions, the steady state approximation, pre-equilibria, unimolecular reactions, Problems.	10
II	Kinetics of Fast reactions: Introduction of Fast reactions, flash photolysis, flow technique, stopped flow technique, relaxation method, chain reactions, free radical polymerization reaction between H ₂ and Br ₂ , explosive reaction, Problems.	04
III	Molecular Reaction Dynamics: Collision theory of bimolecular gas phase reactions, diffusion controlled and activation-controlled reaction solution, activated complex theory of reaction rate, Eyrings equation, reaction between ions, Primary salt effect, Problems.	05

IV	Kinetics of Enzyme Catalyzed reactions: Michaelis mechanism, effect of pH and temperature on enzyme catalyzed reactions. Limiting rate. Line weaver Burk and Eadie equation and plots, inhibition of enzyme action competitive inhibition and non-competitive inhibition, Problems.	05
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Reference Books:

1. Physical Chemistry by P. W. Atkins and De Paul.
2. Physical Chemistry by T. Engel and P. Reid.
3. Physical Chemistry and molecular approach by D. Mequarie and J. Siman.
4. Physical Chemistry for biological sciences by Raymond Chang (Universal books, 2000).



M. C. E. Society's

Abeda Inamdar Senior College

Of Arts, Science and Commerce, Camp, Pune-1

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NAAC accredited 'A' Grade

Course/ Paper Title	CHI-112: Symmetry, Group Theory and Main Group Chemistry
Course Code	21SMCH112
Semester	I
No. of Credits	4 Credits (48 L, 12T)

Aims & Objectives of the Course

Sr. No.	Aims and Objectives
Student should understand and learn;	
1.	The concept of symmetry elements and symmetry operations, representations of symmetry groups.
2.	Basic concepts of symmetry and point groups of molecules.
3.	The group multiplication tables and character tables.
4.	To apply the projection operator for constructing SALCs.

5.	To correlate application of symmetry to spectroscopy and find IR active modes of vibrations.
6.	The detailed chemistry of 's' and 'p' block elements with respect to their compounds, reactions and applications.
7.	Advanced chemistry of Boranes, Fullerenes, Zeolites, Carbon Nanotubes and Polymers

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
Students should be able to;	
1.	Understand concept of symmetry element, symmetry operation and point groups.
2.	Classify molecule in point group
3.	Classify & recognize the symmetry elements and their operations as required to specify molecular symmetry & possible point groups from symmetry elements & be able to find point group of molecules by systemic procedure.
4.	Solve problems projection operator for constructing SALCs
5.	Understand the main group chemistry, compounds of main group chemistry and reaction in main group elements.

Section-I: Molecular Symmetry and its Applications

Unit No.	Title with Contents	No. of Lectures
I	Molecular Symmetry and Symmetry Groups: Symmetry elements and operations, Symmetry planes and reflections, the inversion centre, proper axis and proper rotations, improper axes and improper rotation, products of symmetry operations, equivalent symmetry elements and equivalent atoms, general relations among symmetry elements and symmetry operations, classes of symmetry operations, symmetry elements and optical isomerism, symmetry point groups,	10

	classification of molecular point groups. Defining properties of a group, group multiplication table, some examples of group, subgroups and classes.	
II	Representations of Groups: Matrix representation and matrix notation for geometric transformation, The Great Orthogonality Theorem and its consequence, character tables (No mathematical part), wave functions as basis for irreducible representations.	06
III	Symmetry Adapted Linear Combinations: Projection operators and their use of construct SALC (Construction of SALC for sigma bonding for molecules belonging point groups: D_{2h} , D_{3h} , D_{4h} , C_{4v} , T_d , O_h), normalization of SALC, transformation properties of atomic orbital, MO's for sigma bonding, AB_n molecules, tetrahedral AB_4 and O_h AB_6 cases.	04
IV	Application of Group theory to Infrared Spectroscopy: Introduction, selection rules, polyatomic molecules, possible vibrations in a linear molecule, bending modes, symmetry of vibrations and their IR activity, Group vibration concept and its limitations, IR spectra related to symmetry of some compounds, IR spectra of complex compounds.	04

Reference Books:

1. Chemical Applications of Group Theory by F. A. Cotton
2. Symmetry and spectroscopy of molecules by K. Veera Reddy
3. Group Theory and its Chemical Application, P. K. Bhattacharya
4. Inorganic Chemistry by Shriver and Atkins
5. Concise Inorganic Chemistry by J. D. Lee
6. Inorganic chemistry: principle of structures and reactivity by Huheey, Keiter, Medhi

Section-II: Main Group Chemistry

Unit No.	Title with Contents	No. of Lectures
I	<p>Hydrogen and its compounds:</p> <p>Classification of Hydrides, electron deficient, electron precise and electron rich hydrides; PH₃, SbH₃, AsH₃ Selenides, Tellurides.</p>	02
II	<p>Alkali and Alkaline Earth Metals:</p> <p>Solutions in non - aqueous media, application of crown ether in extraction of alkali and alkaline earth metal.</p>	02
III	<p>Boron Group:</p> <p>Boron Hydrides, preparation, structure and Bonding with reference to LUMO, HOMO, interconversion of lower and higher boranes, metalloboranes, carboranes, reactions of organoboranes, STYX rules and structure of higher boranes.</p>	04
IV	<p>Carbon Group:</p> <p>Allotropes of carbon, Diamond, Graphite, Graphene, fullerenes, carbon nanotube with synthesis, properties, Structure- single walled and multi walled and its application, Intercalation compounds of graphite, Silicates, including zeolites.</p>	03
V	<p>Nitrogen Group:</p> <p>Nitrogen activation, Boron nitride, Oxidation states of nitrogen and their interconversion, PN and SN Compounds, Applications of PN and SN compounds.</p>	03
VI	<p>Oxygen Group:</p> <p>Metal Selenides and Tellurides, Oxyacids and Oxoanions of Sulphur and Nitrogen. Ring, Cage and Cluster compounds of p-block elements.</p>	03
VII	<p>Halogen Group:</p> <p>Interhalogens, Pseudohalogen- Synthesis, Properties and Applications; Structure, Oxyacids and Oxyanions of Halogens</p>	04
VIII	<p>Noble gases:</p> <p>Occurrence, Compounds of Xenon-with fluorine and Oxygen and its uses.</p>	03

Reference Books:

1. Inorganic Chemistry by Shriver and Atkins
2. Concise Inorganic Chemistry by J. D. Lee
3. Principle of Structures and Reactivity by Huheey, Keiter, Medhi
4. Inorganic Chemistry by Catherine Housecraft
5. Inorganic Chemistry by Meissler and Tarr
6. Organometallics by Christoph Elschenbroich
7. "Organometallics: A Concise Introduction" by Christoph Elschenbroich and Albrecht Salzer
8. Basic Organometallic Chemistry by B. D. Gupta and A. J. Elias.



M. C. E. Society's

Abeda Inamdar Senior College

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NAAC accredited 'A' Grade

Course/ Paper Title	CHO-113-Basic Organic Chemistry and Stereochemistry
Course Code	21SMCH113
Semester	I
No. of Credits	4 Credits, (48 L, 12T)

Aims & Objectives of the Course

Sr. No.	Objectives
Student should understand and learn	
1.	Concept of Chemical bonding and reactivity, various effects in organic molecules, Acidity, basicity, aromaticity and the reactive intermediates.
2.	Mechanism of substitution (electrophilic, nucleophilic), addition and elimination reactions.
3.	Mechanism of aromatic electrophilic and aromatic nucleophilic reaction.
4.	Concepts of stereochemistry and stereochemical aspects in organic chemistry.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	The students should; Know and apply the fundamental principles of organic chemistry that include chemical bonding, nomenclature, Acidity, Basicity, Solvent effects, structural isomerism, stereochemistry, chemical reactions and mechanism.
2.	Understand the stability of reaction intermediates.
3.	Understand the criteria for aromaticity in non-benzenoid molecules and other advanced polycyclic aromatics.
4.	Understand the role of various reaction intermediates like carbocation, carbanion, carbenes, radicals, and nitrenes in organic reactions; concept of NGP.
5.	Be able to describe step-wise mechanism of different rearrangement reactions and predict the major product.
6.	Be able to do interconversion of Fischer to Newmann, Newmann to Sawhorse and vice versa, Able to assign R and S to given molecules; understand stereoselective and stereospecific reactions; acquire knowledge on topicity.

Syllabus

Section-I: Basic Organic Chemistry

Unit No.	Title with Contents	No. of Lectures
I	Nature of Bonding in Organic Molecules, Structure and Reactivity: Delocalized chemical bonding, Inductive, Resonance Effect, Conjugation, cross conjugation, hyper conjugation, tautomerism. Acids and Bases, Factors affecting acidity and basicity: Electronegativity and inductive effect, resonance, bond strength, electrostatic effects, hybridization, aromaticity and solvation. Comparative study of acidity and basicity of organic compounds on the basis of pK _a values, Leveling effect and non-aqueous solvents. Acid and base catalysis – general and specific catalysis with examples.	08

II	Aromaticity: Benzenoid and non-benzenoid compounds, Huckel's rule, antiaromaticity, annulenes, azulenes, ring current concepts of aromaticity	02
III	Reactive intermediate: Structure and Stability of Carbocation, Carbanion, Free Radical, Carbenes and Nitrenes	02
IV	Aliphatic Nucleophilic Substitution: The SN ₂ , SN ₁ , mixed SN ₁ and SN ₂ and SET mechanism. The S _N i mechanism. Nucleophile Substitution at an allylic, aliphatic trigonal and vinylic carbon. Factors affecting these reactions: substrate, nucleophilicity, solvent, steric effect, hard-soft interaction, leaving group, ambident nucleophile and regioselectivity.	08
V	Neighboring Group Participation (NGP): The neighboring group participation mechanism, The Neighboring Group Participation by π & σ bonds, anchimeric assistance, classical and non-classical carbocations, phenonium ions, norbornyl system, carbocation rearrangements in neighboring group participation.	04

Reference Books:

1. Organic Chemistry, J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford University Press.
2. Advanced Organic Chemistry, Part A and B, by F.A. Carey and R.J. Sundberg, Plenum Press.
3. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Jerry March, Wiley.
4. Advanced Organic Chemistry: Reactions and mechanism, B. Miller and R. Prasad, Pearson Education.
5. Advanced Organic Chemistry: Reaction mechanisms, R. Bruckner, Academic Press.
6. Understanding Organic Reaction Mechanisms, Adams Jacobs, Cambridge University Press.

7. Writing Reaction Mechanism in organic chemistry, A. Miller, P.H. Solomons, Academic Press.
8. Principles of Organic Synthesis, R.O.C. Norman and J.M Coxon, Nelson Thornes.
9. Advanced Organic Chemistry: Reactions and mechanism, L.G. Wade, Jr., Maya Shankar Singh, Pearson Education.
10. Mechanism in Organic Chemistry, Peter Sykes, 6th edition onwards.
11. Mechanism and structure in Organic Chemistry – E. S. Gould (Holt, Rinehart and Winston)

Section-II: Reaction of Aromatic compounds and stereochemistry

Unit No.	Title with Contents	No. of Lectures
I	<p>Aromatic Electrophilic Substitution:</p> <p>The arenium ion mechanism, orientation and reactivity, energy profile diagram, The ortho/ para ratio ipso attack and reactions. Orientation in other ring system-Naphthalene, Anthracene, five and six membered heterocycles. AER reactions - Diazonium coupling, Vilsmeier reaction, Gattermann–Koch reaction, Reimer Tiemann reaction.</p>	07
II	<p>Aromatic Nucleophilic Substitution:</p> <p>The S_NAr, S_N1, Benzyne intermediate & S_NR₁, Mechanisms, Reactivity effect of substrate structure, leaving group and attacking nucleophile. Nucleophilic reactions in six membered heterocycles.</p>	05
III	<p>Stereochemistry:</p> <p>Recapitulation isomerism, CIP rule, geometrical isomerism and E/Z configurations, representation of prospective formulae and interconversion, configurational isomerism and R/S nomenclature in C, N, S, P containing compounds, Optical activity.</p> <p>Stereochemical Relationship- enantiomeric relationship, diastereomeric relationship. Prochirality, Prochiral relationship – Prochiral center, ligands, prochiral faces and their nomenclature. (Pro R/S, Re/Si faces).</p> <p>Topicity- Homotopic, enantiotopic and diastereotopic ligand and faces</p>	12

	<p>with examples, Diastereoisomerism in Acyclic and Cyclic systems.</p> <p>Optical activity in the absence of chiral carbon and their nomenclature: Biphenyls (atropisomerism), allenes, Exocyclic alkylidenes, spiranes, ANSA compounds, paracyclophanes, trans cyclooctenes, helical compounds (P & M nomenclature).</p> <p>Stereospecific and stereoselective reactions with examples, Stereochemistry and Conformational analysis of di, tri, tetra-substituted cyclohexane 6- membered rings, R/S nomenclature in chair cyclohexane compounds.</p>	
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Reference Books:

1. Organic Chemistry, J. Claydens, N. Greeves, S. Warren and P. Wothers, Oxford University Press.
2. Advanced Organic Chemistry, Part A and B, by F.A. Carey and R.J. Sundberg, Plenum Press.
3. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, Jerry March, Wiley.
4. Heterocyclic Chemistry 5th Edition by John A. Joule and Keith Mills
5. Heterocyclic chemistry by R.K. Bansal
6. Stereochemistry of carbon compounds - E. L. Eliel
7. Stereochemistry of carbon compounds - E. L. Eliel and S. H. Wilen
8. Stereochemistry of organic compounds - Nasipuri
9. Stereochemistry of organic compounds - Kalsi



M. C. E. Society's

Abeda Inamdar Senior College

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NAAC accredited 'A' Grade

Course/ Paper Title	CHA-114A: Biochemistry (Elective/Optional Paper)
Course Code	21SMCH114A
Semester	I
No. of Credits	2 Credits (24 L, 06T)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	Student should understand and learn; fundamental concepts in Chemical Biology and methods of chemistry used to solve problems in molecular and cell biology.
2.	understand structure, function of carbohydrate, lipids, amino acids, nucleotides, enzymes in biochemistry.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	After completion of this course, successful students will; To impart the student's thorough idea in the chemistry of carbohydrates, amino acids, proteins, and nucleic acids etc.
2.	Be able to describe the chemical basis for replication, transcription, translation, and how each of these central processes can be expanded to include new chemical matter.

Syllabus for CHA-114A: Biochemistry

Unit No.	Title with Contents	No. of Lectures
I	<p>Carbohydrates:</p> <p>Occurrence, classification, characteristics, structure and functions of monosaccharides, disaccharides, trisaccharides and polysaccharides, Structure and conformation of sugars, selected chemical reactions of the functional groups.</p>	06
II	<p>Lipids:</p> <p>Classification and types of lipids, Structure, nomenclature and properties of fatty acids, Structure, classification, properties and functions of phospholipids, sphingolipids and Glycolipids, Composition and biological role of lipoproteins</p>	06
III	<p>Amino Acids, Nucleotides and Water:</p> <p>Structure, nomenclature, classification, acid-base behavior and chemical reactions of amino acids, Stereoisomerism and optical properties of amino acids, Modified amino acids, Nucleotides, Water and its physicochemical properties, Ionization of water, pH scale, Henderson-Hasselbalch equation.</p>	06
IV	<p>Enzymes:</p> <p>Introduction and classification, Enzymes as biological catalysts: characteristics, nomenclature and classification, Enzyme assay and enzyme activity, Enzyme units, Coenzymes: structure and function, Multifunctional enzymes and multienzyme complexes, Isoenzymes and their analysis, Ribozyme and Catalytic antibodies.</p>	06

Reference Books: -

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York).
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York).
3. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York).



M. C. E. Society's

Abeda Inamdar Senior College

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NAAC accredited 'A' Grade

Course/ Paper Title	CHA-114B: Material Science (Elective/Optional Paper)
Course Code	21SMCH114B
Semester	I
No. of Credits	2 Credits, (24 L, 06T)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	Students should understand and learn; composite and nano materials and their properties.
2.	magnetic materials and properties.
3.	composite materials and properties.
4.	compare materials according to their properties.
5.	synthesis and application of nano materials.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	At the end of course students will be able to; describe basic definition and conception of materials and classify materials according to their types
2.	give information about magnetic, composite and nano materials and their properties
3.	understand synthetic routes like top-down, bottom-up and other novel methods of nano material synthesis
4.	understand the factors responsible of dramatic changes in properties of nano materials with decrease in size.

Syllabus for CHA-114B: Material Science

Unit No.	Title with Contents	No. of Lectures
I	<p>Introduction to material science, types of materials:</p> <p>Magnetic Materials Atomic magnetism and solids, type of magnetic materials, the exchange interactions, hysteresis loops and their classification, calculation of magnetic moment from saturation magnetization, magnetic domains. Examples off magnetic materials: soft and hard ferrites, i.e., structure and magnetic interactions in spinel's, garnets, hexagonal ferrites. Application of magnetic materials. [Ref. 1]</p>	08
II	<p>Composite Materials:</p> <p>Definition, glass transition temperature, fibers for reinforced-plastic composite materials (i.e. glass fibers, carbon fibers, and aramid fibers); concretes and asphalt materials. Application of composite materials. [Ref. 2]</p>	06
III	<p>Nano-Materials:</p> <p>Introduction to Nano-Materials, Definition and types of nano-materials, Size dependent properties, Synthesis of nanomaterials: top-down (chemical etching, sputtering, ball/mechanical milling, thermal ablation) and bottom-up (sol-gel, laser pyrolysis, aerosol process, vapor deposition, chemical precipitation, biological methods), application of nano-materials. [Ref. 3]</p>	06
IV	<p>Analysis techniques of materials:</p> <p>Analysis techniques of materials: Thermal techniques (TG, DTA, DSC), X-Ray Diffraction Powder, Scanning electron microscopy, Transmission electron microscopy. [Ref. 3]</p>	04

Reference Books:

1. Materials Science and Engineering – V. Raghavan (2nd Edition 1980). [Chap. No. 16]

2. Material science and engineering an introduction – William D Callister, David G Rethwisch, 8th edition. [Chap. No. 15]
3. Insight into Specialty Inorganic Chemicals – David Thompson (The Royal Society of Chemistry, 1995 chapter 13 and 14).
4. Introduction to Solids – L. V. Azaroff (Tata McGraw Hill).
5. Elements of Materials Science and Engineering – Van Vlack (5th Edition, Wiley 1988)
6. Nature and Properties of Engineering Materials – Z. D. Jastrzebski (John Wiley Sons, 1989)
7. Principles of Materials Science and Engineering – William F. Smith (Wiley, 1991).
8. Introduction to nanotechnology, Charles P. Poole, Jr. Frank J. Owens, John Wiley Sons, Inc., publication. [Chap no. 3]
9. The Chemistry of Nanomaterials edited by C.N.R. Rao, A.Muller, A.K. Cheetham, Wiley-VCH Verlag GmbH & co. Volumes 1&2
10. Nanomaterials by Dr. Sulbha Kulkarni.
11. Instrumental Methods of Analysis-G-Chatwal and S. Anand (Himalaya Publication; 1988).
12. Physical Methods for Chemists - R. S. Drago (2nd Edition, Saunders).



M. C. E. Society's

Abeda Inamdar Senior College

Of Arts, Science and Commerce, Camp, Pune-1

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NAAC accredited 'A' Grade

Course/ Paper Title	CHP-115: Physical Chemistry Practical –I
Course Code	21SMCH115
Semester	I
No. of Credits	2 Credits, (48 L, 12T)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	Students should understand and learn; The application of theoretical principles and experimental designs in chemical kinetics.
2.	The principle, working, calibration and handling of spectrophotometer and pH meter.
3.	The application of spectrophotometry and pH-metry calculation and determination of statistical parameters.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	Students should be able; To calculate and prepare solution of various molar and normal concentrations.
2.	To find out the acidity, Basicity and pKa Value on pH Meter.
3.	To determination of ionic product of water and titration of a mixture by conductometry.
4.	To use instruments like pH Meter, Colorimeter, Conductometer, Potentiometer and Polarograph with details of operating procedures.
5.	To carry out experiment based on non-instrumental methods like chemical kinetics, viscosity, partial molar volume and calculate statistical parameters related to errors and deviations.

Syllabus for CHP-115: Physical Chemistry Practical –I

Unit No.	Title with Contents	Practical Sessions
I	<p>Chemical Kinetics (Any three experiments)</p> <ol style="list-style-type: none"> 1. Kinetic decomposition of diacetone alcohol by dilatometry. 2. Determination of an order of a reaction. 3. Brönsted primary salt effect. 4. Kinetics of oxidation of ethanol by $K_2Cr_2O_7$ 	03
II	<p>Colorimetry and Spectrophotometry (Any four experiments)</p> <ol style="list-style-type: none"> 1. Simultaneous determination of Ni and Co by spectrophotometry. 2. Simulations determination of Mn and Cr by spectrophotometry. 3. To study the adsorption of certain dyes such as methyl violet, picric acid or methylene blue on charcoal. 4. To determine the indicator constant of bromocresolpurple by half height method. 5. Estimation of Cu(II) by titration with Na_2 EDTA by colorimetry 6. a) Determination of energy of n to Π^* transition in acetone and study of effect of solvent on energy of this transition by recording absorbance spectra in n-hexane and water. b) To study the effect of the extended conjugation on the λ_{max} of p-nitro phenol by recording spectrum in acidic and alkaline medium. 	04
III	<p>pH Metry (any two experiments)</p> <ol style="list-style-type: none"> 1. Determination of the acid and base dissociation constant of an amino acid and hence the isoelectric point of the acid. 2. Determination of dissociation constants of tribasic acid (phosphoric acid) 3. Construct pH curve for titration of strong base – strong acid, strong base - weak acid and predict the best indicator in these titrations (methyl orange, bromo cresol green, phenolphthalein, etc.) 	02

IV	Non-Instrumental (Any Three experiments) 1. Determination of degree of dissociation of calcium nitrate and find its Van't Hoff factor. 2. Determination of molecular weight by steam distillation. 3. Glycerol radius by viscosity. 4. Partial Molar Volume (Polynometry) Determination of the densities of a series of solutions and to calculate the molar volumes of the components.	02
IV	Statistical treatment of experimental data (Compulsory) Statistical treatment of experimental data (calculation of mean and standard deviation for given data and least square method for calibration curve method)	01

Reference Books:

1. Practical physical chemistry, A. Findlay, T. A. Kitchner (Longmans, Green and Co.).
2. Experiments in Physical Chemistry, J. M. Wilson, K.J. Newcombe, A. R. Denko. R.M.W. Richett (Pergamon Press).
3. Senior Practical Physical Chemistry, B. D. Khosla and V.S. Garg (R. Chand and Co., Delhi.).
4. Experimental Physical Chemistry, R. C. Das and B Behera, Tata McGraw Hill, 1983.
5. Advanced Experimental Chemistry, Vol. I -Physical by Gurtu& R. Kapoor, S Chand & Co.
6. Systematic Experimental Physical Chemistry by S. W. Rajbhoj and T. K. Chondhekar, Anjali Publication.



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NAAC accredited 'A' Grade

Course/ Paper Title	CHI-116: Inorganic Chemistry Practical –I
Course Code	21SMCH116
Semester	I
No. of Credits	2 Credits, (48 L, 12T)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	Students should understand and learn the pre-requisite concepts in the Ore and Alloy analysis.
2.	Student should understand the experimental aspects of synthesis of coordination compounds.
3.	Students should understand and learn the characterization of compound based through various techniques.
4.	Students should understand and learn basic principle of nanoparticles.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	At the end of course student will be able to; carry out Ore and Alloy analysis, run assays and synthesize coordination compounds.
2.	characterize nanoparticles through spectroscopic methods
3.	run ion-exchange experiments

Syllabus for CHI-116: Inorganic Chemistry Practical –I

Total 12 practical to be conducted from following;

Unit No.	Title with Contents	Practical Sessions
I	<ol style="list-style-type: none">1. Data analysis, errors, error analysis, least square method.2. Determination of Silica and Manganese from pyrolusite ore.3. Determination of silica and iron from hematite ore.4. Synthesis of ZnO from zinc oxalate - precursor method and determine band gap by absorption spectroscopy.5. Synthesis of Colloidal silver nanoparticles and determine band gap by absorption spectroscopy.6. Synthesis of Fe₂O₃ nanoparticles sol-gel / coprecipitation / hydrothermal (any one method).7. Study of adsorption of phosphate ion on α-Fe₂O₃8. Removal and kinetics of photo catalytic dyes, degradation (methylene blue) by ZnO or TiO₂ photo catalysis.9. Synthesis and photochemistry of K₃[Fe(C₂O₄)₃].3H₂O.10. Synthesis and Purity of Chloropenta-ammine cobalt (III) chloride.11. Synthesis and Purity of Nitro penta-amminecobalt (III) chloride.12. Synthesis and Purity of Bis [Tris Cu(I)thiourea].13. Separation of mixture of Zn (II) and Mg (II) using Amber lite IRA 400 anion exchanger and quantitative estimation of separated ions Zn (II) and Mg (II).14. Separation of mixture of Zn (II) and Cd (II) using Amber lite IRA 400 anion exchanger and quantitative estimation of separated ions Zn (II) and Cd (II).	12

Reference Books:

1. Vogel's Textbook of Inorganic Quantitative Analysis.
2. Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horwood publishing, Chichester) 1999.
3. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House.
4. General Chemistry Experiments, Anil. J Elias, University Press (2002).
5. Practical physical Chemistry, B. Vishwanathan and P. S. Raghwan, Viva Books.



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Abeda Inamdar Senior College

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NAAC accredited 'A' Grade

Course/ Paper Title	CHO-117: Organic Chemistry Practical –I
Course Code	21SMCH117
Semester	I
No. of Credits	4 Credits, (48 L, 12T)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	Students should understand and learn safety measures in chemical laboratory.
2.	Students should understand and learn concept of organic purification techniques.
3.	Students should understand and learn solvent drying and purification techniques.
4.	Students should understand and learn drawing of molecules on chemistry drawing applications.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	Student will be able to carry out distillation, fractional distillation, drying and storage of organic solvents.

2.	Student will be able to carry out different separation techniques.
3.	Student will be able to synthesize organic compounds and derivatives, their purifications and run TLC.
4.	Student will be able to draw the structure by using software and predict NMR and CMR.

Syllabus for CHO-117: Organic Chemistry Practical – I

Unit No.	Title with Contents	Practical Sessions
I	<p>Introduction to Laboratory Safety:</p> <p>Meaning of safety signs on container of chemicals, safety handling of chemicals, MSDS sheets: Detailed explanation at least for 4 different types of substances (e.g. nitric acid, benzene, potassium dichromate, bromine, etc.), Handling of glassware's and care to be taken, handling of organic flammable as well as toxic solvents in laboratory, use of safety goggles, shoes and gloves, fire extinguisher and its use, action to be taken in accidental cases e.g. cleaning of acid spill over, use eye wash station and bath station in emergency, etc. (compulsory)</p>	01
II	<p>Purification Techniques (8 Experiments):</p> <ol style="list-style-type: none"> 1. Purification of two organic solids by recrystallization using solvents other than water. 2. Purification of two organic liquids by distillation technique. 3. Purification of two organic solids by Sublimation method. 4. Thin Layer Chromatography technique of two components mixtures. 5. Preparative TLC. 6. Column Chromatography technique. 7. Solvent Extraction method. 8. Vacuum distillation under pressure. 	08

III	Purification of common organic Solvent (Using any two techniques): Choice of solvent for organic reactions, effect of solvents in Organic preparations, boiling range of different solvents, dry solvents and methods of solvent purifications.	02
IV	Use of ChemDraw, ISIS, Marvin Sketch: Draw the structure of organic compounds, 3D structure of compounds, reaction sequence. Get the correct IUPAC name. Prediction of NMR, CMR for organic compounds.	01

Reference Books:

1. Practical Organic Chemistry A. I. Vogel (Longmans).
2. Text Book of practical organic Chemistry F. G. Mann & B.C. Sanders.

SEMESTER-II



M. C. E. Society's

Abeda Inamdar Senior College

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NAAC accredited 'A' Grade

Course/ Paper Title	CHP-121: Molecular Spectroscopy, Chemical Bonding and Nuclear Chemistry
Course Code	21SMCH121
Semester	II
No. of Credits	4 Credits (48 L, 12T)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	Student should understand fundamentals of molecular spectroscopy.
2.	Student should be able to correlate classical and quantum approach in spectroscopic methods.
3.	Student should be able to solve numerical problems based on various spectroscopic methods.
4.	Student should understand the application of spectroscopic methods and their relevance.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	Students will be able to recognize spectroscopy in microwave, Rotational spectra of rigid diatomic molecules, selection rules, interaction of spectral lines.
2.	Students will be able to understand nature of vibrating diatomic

	molecule, energy levels of a diatomic molecule, simple harmonic and anharmonic oscillator, Scattering of light and Raman Spectrum. rotational and vibrational Raman Spectra.
3.	Students will be able to explain fine structure of ESR absorption, Hyperfine structure, Double resonance in ESR, Techniques of ESR spectroscopy.
4.	Students will be able to understand concepts of Nuclear and Radiation Chemistry, Applications of Radioisotopes.

Section-I: Molecular Spectroscopy

Unit No.	Title with Contents	No. of Lectures
I	Introduction to molecular spectroscopy: Characteristics and regions of electromagnetic radiation, quantization of energy, Width and intensity of spectral transition, problems.	03
II	Microwave Spectroscopy: Principle of microwave spectroscopy, Types of molecules on the basis of moment of inertia and rotational spectra of di- and polyatomic molecules, problems.	04
III	Infra-red Spectroscopy: Principle of Infra-red Spectroscopy, the vibrating diatomic molecule, harmonic and anharmonic oscillator, the diatomic vibrating rotator, breakdown of the Born-Oppenheimer approximation, the vibrations of polyatomic molecule, Fourier transform spectroscopy and its advantages, The carbon dioxide laser, Applications, problems.	06
IV	Raman Spectroscopy: Quantum and classical theory of Raman effect, pure rotational Raman spectra, vibrational Raman spectra, polarization of light and Raman effect, structure determination from Raman and Infra-red spectroscopy, applications, problems.	05
V	Electronic Spectroscopy of molecules: Electronic spectra of diatomic molecules - The Born- Oppenheimer	06

	approximation, Vibrational coarse structure, Frank- Condon principle, dissociation energy and dissociation product, Rotational fine structure of electronic-vibration transition, The forttrat diagram, Pre-dissociation, molecular photoelectron spectroscopy, problems.	
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Reference Books:

1. Fundamentals of molecular spectroscopy by C. N. Banwell and E. M. McCash.
2. Inorganic spectroscopy by R. S. Draggo.
3. Quantum Mechanical Foundations of Molecular Spectroscopy, By Max Diem, Wiley Publisher.
4. Fundamentals of Quantum Chemistry Molecular Spectroscopy and Modern Electronic Structure Computations by Michael Mueller · 2007, Springer.
5. Basic Atomic and Molecular Spectroscopy, By John Michael Hollas, 2002.

Section-II: Radioactivity and Quantum Chemistry

Unit No.	Title with Contents	No. of Lectures
I	Radioactivity Recapitulation, Types of radioactive decay, general characteristics of radioactive decay, decay kinetics, general expression for the activity of a daughter nuclide, Problems.	04
II	Applications of Radioactivity Typical reaction involved in the preparation of radioisotopes, The Szillard- Chalmers reaction, Radiochemical principles in the use of tracers, Isotopes in elucidating reaction mechanism and structure determination, physic-chemical research - The solubility of a sparingly soluble substances, surface area of a powder or precipitate rates of diffusion, Analytical applications- Isotope dilution analysis, Neutron activation analysis, Radiometric titrations, Medical applications- Thyroiditis, Assessing the volume of blood in a patient, Industrial applications thickness measurements and control, friction and wear out, gamma radiography, Problems.	06

III	<p>Quantum Chemistry</p> <p>Applications of quantum chemistry- blackbody radiation, photoelectric effect, de Broglie hypothesis and uncertainty principle and its experimental evidence. Schrödinger wave equation, particle in one dimensional box, Normalization and orthogonality of wave function, particle in three-dimensional box, hydrogen like atoms (no derivation). Operators: algebra of operators, commutative property, linear operators, commutator operator, the operator ∇ and ∇^2, Problems.</p>	08
IV	<p>Chemical Bonding</p> <p>Valence bond theory, hybrid orbitals, geometry and hybridization, molecular orbital theory for di and tri atomic molecule, linear variation method, approximations underlying Huckel theory, applications to simple π-systems, problems.</p>	06

Reference Books:

1. Elements of Nuclear Chemistry by H. J. Arnikar
2. Source book of Atomic energy by S. Glasstone and D. Van
3. Chemical applications of radioisotopes by H. J. M. Brown.
4. Physical Chemistry by T. Engel and P. Reid
5. Physical Chemistry and molecular approach by D. Mequarie and J. Siman
6. Quantum Chemistry by I. Levine
7. Quantum Chemistry by R.K. Prasad



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NAAC accredited 'A' Grade

Course/ Paper Title	CHI-122: Co-Ordination and Bio-Inorganic Chemistry
Course Code	21SMCH122
Semester	II
No. of Credits	4 Credits (48 L, 12T)

Aims & Objectives of the Course

Sr. No.	Objectives
Student should understand the following;	
1.	The concepts of metal ligand bonding in transition metal complexes.
2.	The ligand field effect, R-S terms in coordination complex.
3.	Analysis of electronic spectra of transition metals.
4.	The role of metal ion in biological system.
5.	The bioinorganic chemistry of hemoglobin and myoglobin.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	Students will be able to understand the concept of ligand field.
2.	Students will be able to explain d-orbital splitting pattern in different geometries like octahedral, tetrahedral.
3.	Students will be able to calculate magnetic moment & crystal field stabilization energy of metal complexes.
4.	Students will be able to explain high spin and low spin complexes & formation of metal complexes in solution.
5.	Students will be able to explain concept of bioinorganic chemistry.
6.	Students will be able to explain and apply HSAB rule chelation, macro cyclic, cryptate effect.

Section-I: Coordination Chemistry

Unit No.	Title with Contents	No. of Lectures
I	Concept and Scope of Ligand Fields Quantum numbers, Free ion Configuration, Terms and States, Energy levels of transition metal ions, free ion terms, microstates, term wave functions, spin-orbits coupling.	05
II	Ligand Field Theory of Coordination Complexes Effect of ligand field on energy levels of transition metal ions, weak cubic ligand field effect on Russell- Saunders terms, Orgel diagrams, strong field effect, correlation diagrams, Tanabe-Sugano Diagrams, Spin-Pairing energies.	07
III	Electronic spectra of Transition Metal Complexes Introduction, band intensities, band energies, band width and shapes, transition metal spectra of 1 st , 2 nd and 3 rd row ions and complexes, electronic spectra of Lanthanide and Actinide, spectrochemical and nephelauxetic series, charge transfer and luminescence spectra, calculations of Dq, B, β parameters, percentage of covalent character for metal-ligand bond.	06
IV	Magnetic Properties of Coordination Complexes Origin magnetism, types of magnetism, Curie law, Curie-Weiss Law, Magnetic properties of complexes, Para magnetism, 1 st and 2 nd order Zeeman effect, quenching of orbital angular momentum by Ligand fields, Magnetic properties of A, E and T ground terms in complexes, spin free and spin paired equilibria, temperature dependence of magnetism.	06

Reference Books:

1. Ligand field theory and its applications by B. N. Figgis and M.A. Hitachman
2. Symmetry and spectroscopy of molecules by K. Veera Reddy
3. Elements of Magnetochemistry by A. Syamal R. L. Dutta

Section-II: Bio-Inorganic Chemistry

Unit No.	Title with Contents	No. of Lectures
I	<p>Metal ions in biological system</p> <p>Occurrence and availability of Inorganic elements in organisms, Essential and trace metal ions in biological system. Deficiency/excess of Mn, Co, and Zn metal ions, structure of chlorophyll, Photosynthesis, Photo system I and Photo system II. Metalloenzymes; cytochromes and iron-sulphur proteins, nitrogen fixation, Zinc enzymes; carboxypeptidase, carbonic anhydrase. Iron enzymes-catalase and peroxidase. Copper enzyme –superoxide dismutase. Cobalt enzyme; cyanocobalamin.</p>	09
II	<p>Concepts of Inorganic Chemistry in Bioinorganic Chemistry</p> <p>Thermodynamic aspects - HSAB concept, chelate effect and Irving-William series, pKa values of coordinated ligands, Tuning of redox potential, Biopolymer effects. Kinetic aspects- Electron transfer reaction, Electronic substitution reaction. Reactions of coordinated ligands and Template effect, concept of spontaneous self-assembly model compounds.</p>	08
III	<p>Functions and Transport of Alkali and Alkaline Earth Metal Ions</p> <p>Roll of Alkali and alkaline earth metals in neuro sensation, Na⁺/K⁺ - ATPase ion pump for active transport of Na⁺ and K Ionophores: Natural and Synthetic, Application of ionophores.</p>	03
IV	<p>Biochemistry of following Elements</p> <p>Ca in Blood coagulation, Iron in Ferritin, Transferrin, Fe-S clusters, Porphyrin based system.</p>	04

Reference Books:

1. Principle of Bioinorganic Chemistry by S. J. Lippard and J. M. Berg

- Bioinorganic Chemistry: Inorganic Elements in Chemistry of Life by W. Kaim and B. Schwederski
- Bioinorganic Chemistry, I. Bertini, H.B. Gray, S. J. Lippard and J.S. Valentine, University Science Books.
- Inorganic Biochemistry, G. L. Eichhorn, vol. I and II., Elsevier.
- Progress in Inorganic Chemistry, Vols. 18 and 38, S. J. Lippard, Wiley.



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Abeda Inamdar Senior College

Of Arts, Science and Commerce, Camp, Pune-1

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	CHO-123: Synthetic Organic Chemistry and Spectroscopy
Course Code	21SMCH123
Semester	II
No. of Credits	4 Credits (48 L, 12T)

Aims & Objectives of the Course

Sr. No.	Objectives
Student should understand and learn;	
1.	About the reagents which causes selective oxidation / reduction in various compounds with mechanism.
2.	The mechanism of rearrangement reactions.
3.	Various types of reactions with stereo chemical aspects, regio-selectivity and chemo-selectivity, orientation and reactivity with mechanisms.
4.	The spectroscopic methods in Organic Chemistry including U.V., I.R., NMR, and CMR and solve problems on structure determination.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
Students will be able to understand	
1.	The role of oxidizing and reducing agent, write reaction mechanism and stereochemistry of rearrangements reaction and make products as per migratory aptitude of different groups.
2.	The solve problems on addition and elimination reactions, mechanism and the stereo chemical outcomes.
3.	The basic principles of spectroscopic methods in structure elucidation of organic compounds and elucidate structures from spectroscopic data or spectra.
4.	The explain appropriate key factors responsible for the spectroscopic data acquisition and solve problems based on combined data of UV, IR, MS, ¹ H-NMR, ¹³ C-NMR.

Section-I: Synthetic Organic Chemistry

Unit No.	Title with Contents	No. of Lectures
I	<p>Oxidation and Reduction Reactions:</p> <p>Oxidizing agents: CrO₃, PDC, PCC, KMnO₄, MnO₂, Swern, SeO₂, Pb(OAc)₄, Pd-C, RuO₄, OsO₄, m-CPBA, O₃, NaIO₄, HIO₄, TEMPO, IBX, CAN, Dess-Martin, DDQ, Ag₂O.</p> <p>Reducing agents: Boranes and hydroboration reactions, MPV reduction and reduction with H₂/Pd-C, Raney-Ni, NaBH₃CN, Willkinsons catalyst, DIBAL and Wolff-Kishner reduction, Birch, Clemenson, Dissolving metal reduction.</p>	06
II	<p>Rearrangements:</p> <p>Beckmann, Hofmann, Curtius, Schmidt, Wolf, Lossen, Baeyer-Villiger, Sommelet, Favorskii, Pinacole-Pinacolone, Benzil-Benzillic acid, Claisen and Cope Rearrangements, Fries Migration.</p>	06

III	Addition to Carbon-Hetero Multiple Bonds: Addition of Grignard Reagent, Organo lithium, Organo Zinc, and Organo Copper reagents to Carbonyl and unsaturated Carbonyl compounds.	04
IV	Addition Reactions: Mechanistic and Stereo chemical aspects of addition reactions involving electrophiles, nucleophiles and Free radicals, Regio and Chemo selectivity, Orientation and reactivity, Michael reaction.	03
V	Elimination Reactions: E ₂ , E ₁ , E _{1cB} Mechanisms, Orientation, Regioselectivity, stereochemistry in elimination, reactivity effect of structure attacking and leaving groups, competition between substitution & elimination, syn eliminations- pyrolytic elimination, Cope elimination, Chugaev reaction.	03
VI	Combined synthetic sequence and mechanism problems on above units.	02

Reference Books:

1. Organic Chemistry–by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford)
2. Mechanism and structure in Organic Chemistry E.S. Gould
3. Advanced Organic Chemistry –by J. March 6th Edition
4. Advanced Organic Chemistry (Part A) –by A. Carey and R.J. Sundberg
5. A guidebook to mechanism in Organic Chemistry – Peter Sykes 6th Ed.
6. Modern methods of organic synthesis, W. Carrathers, Cambridge Univ. P

Section-II: Organic Spectroscopy

Unit No.	Title with Contents	No. of Lectures
I	UV spectroscopy: Recapitulation of UV spectroscopy, solvent effect on UV, calculation of λ_{max} .	02

II	IR spectroscopy: Recapitulation of IR spectroscopy, Principle, spectra of different functional group, effect of conjugation, effect of ring size, H-bonding, inductive effect, resonance effect on IR frequency.	03
III	¹H-NMR spectroscopy: Basic principle, NMR active nuclei, chemical and magnetic nonequivalence, Chemical shifts and factors influencing chemical shift: electronegativity, NMR solvent polarity, temperature, anisotropic effect. Multiplicity patterns and Coupling Constants: Pascal's triangle, understanding of tree diagram, complex splitting patterns in aromatic, vinylic, saturated monocyclic compounds, bicyclic compounds. Integration and uses of it in mixture, molar and ee% calculation.	08
IV	¹³C-NMR: Introduction of CMR, Basic of CMR: Chemical shift and factors affecting chemical shifts in ¹³ C-NMR, off resonance and proton decoupled spectra. Example based of ¹³ C-NMR signals.	04
V	Mass Spectrometry (MS): Basic principle of MS, m/z in mass, type of mass spectra, significance of M ⁺ (m/z) in determination of molecular formula, Rule of 13, Nitrogen rule, isotope peaks, problem bases on HRMS.	03
VI	Combined problems: Problems based on UV, IR, MS, ¹ H-NMR, ¹³ C-NMR should be solved.	04

Reference Books:

1. Introduction to Spectroscopy by Donald L. Pavia and Gary M. Lampman.
2. Spectrometric Identification of Organic Compounds by Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce.
3. NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry by Harald Günther.
4. Organic Spectroscopy, P. S. Kalsi.

5. UV-VIS Spectroscopy and Its Applications by Perkampus, Heinz-Helmut.
6. Infrared Spectroscopy: Fundamentals and Applications by Barbara H. Stuart.
7. Understanding NMR Spectroscopy by James Keeler.
8. Applications of NMR Spectroscopy by Atta-ur-Rahman, M. Iqbal Choudhary.
9. Solving Problems with NMR Spectroscopy by Atta-ur-Rahman Muhammad Choudhary Atiatul- Wahab.



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NAAC accredited 'A' Grade

Course/ Paper Title	CHA-124A: Advanced Analytical Chemistry (Elective/Optional Paper)
Course Code	21SMCH124A
Semester	II
No. of Credits	2 Credits (24 L, 06T)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	Student should understand and learn the concept of electro analytical methods.
2.	Student should understand and learn principle and working of analytical instruments
3.	Student should understand and learn concepts in spectroscopy and chromatography

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
	Students should able to understand;

1.	Various terms and instrumentation in electrochemistry.
2.	The principle, working and application different spectroscopic techniques.
3.	Various terms in spectroscopy and chromatography.
4.	Basic principles and instrumentations of chromatography techniques.
5.	And solve numerical problems on electrochemistry, spectroscopy and chromatography.
6.	The spectroscopic and chromatography methods of analysis.

Syllabus for CHA-124A: Advanced Analytical Chemistry

Unit No.	Title with Contents	No. of Lectures
I	<p>Electro Analytical methods:</p> <ol style="list-style-type: none"> 1. Potentiometric methods: Reference electrodes and indicator electrodes. The hydrogen, calomel, Ag-AgCl electrode. The glass electrode- its structure, performance and limitations. Measurement of pH, Potentiometric titrations- redox and precipitation titrations. 2. Electrogravimetry: Principle and method. Determination of Copper. Separation of metal ions. 3. Conductometry: Principle and method. Conductometric titrations. 4. Coulometry: Principle and method. Coulometric titrations. 5. Voltametry: principle and method of polarography, cyclic voltammetry, stripping voltammetry and amperometry. 	12
II	<p>Spectroscopy:</p> <p>Principle, instrumentation, and applications of Colorimetry, UV-Visible Spectroscopy, Fluorescent and Emission Spectroscopy, IR Spectroscopy, Atomic Absorption Spectrometry, NMR, ESR, CD, ORD, Raman, Atomic force microscopy, and X-Ray Crystallography. (Ref. 6 to 10)</p>	06

III	<p>Chromatography: Partitioning and Counter Current distribution; Principle, instrumentation, and applications of Paper chromatography, Thin layer chromatography (TLC), Gel permeation (size exclusion) chromatography, Ion exchange chromatography, Affinity chromatography, Immobilized metal ion affinity chromatography (IMAC), Hydrophobic interaction chromatography, Gas chromatography, HPLC, HPTLC, RP-HPLC, and FPLC. (Ref. 6 to 10).</p>	06
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Reference Books:

1. Principles of Instrumental Analysis, Skoog, West, Holler, 6th Ed. Cengage Publication.
2. Introduction to Instrumental Analysis by R. D. Braun, Book Syndicate, 2006
3. Instrumental Methods of Chemical Analysis, by Chatwal. G. R., Anand, Sham K., 5th Edition, Himalaya Publishing House, 2005
4. Introduction to instrumental methods of analysis, M. H. Gordon and R. Macrae, Springer.
5. Instrumental Methods of Chemical Analysis, Dr. B. K. Sharma, Krishna Prakashan Media, 1981
6. Principles of Physical Biochemistry, Kensal E. Van Holde, W.C. Johnson, P. Shing O (2006), 2nd edition, Pearson Education International.
7. Physical Biochemistry: Principles and Application, David Sheehan (2000), John Wiley and Sons.
8. Principles and Techniques of Biochemistry and Molecular Biology, K. Wilson and J. Walker (2010) 7th ed., Cambridge University Press.
9. Physical Biochemistry, David Freifelder (1982), 2nd ed., W.H. Freeman & Co.
10. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, Irwin H. Segel (1976), 2nd Ed., John Wiley & Sons.



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NAAC accredited 'A' Grade

Course/ Paper Title	CHA-124B: Organometallic Chemistry (Elective/Option Paper)
Course Code	21SMCH124B
Semester	II
No. of Credits	2 Credits (24 L, 06T)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	Student should understand and learn the ligand and metal ion interactions and related laws.
2.	Student should understand and learn catalytic role and significance of organometallic systems.
3.	Student should understand and learn concepts, reactions and mechanism of coordination compounds.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	The student will gain the knowledge about organometallic chemistry and important classes of ligands.
2.	The student will have understanding of nomenclature, coordination modes, geometries and reactions.
3.	The student will have understanding of electronic properties within organometallic compounds.
4.	The student will be able to explain relationship between the structures, chemical bonds in organometallic chemistry and elucidate mechanisms in catalysis.

Syllabus for CHA-124B: Organometallic Chemistry

Unit No.	Title with Contents	No. of Lectures
I	<p>Organometallic Chemistry</p> <p>Organic ligands and nomenclature, 18 electron rule: counting electrons, ligands having extended pi system, bonding between Metal Atoms and organic pi systems: linear pi system, cyclic pi system, spectral analysis and characterization of organometallic complexes: IR and NMR, examples.</p>	06
II	<p>Organometallic Reactions and Catalysis</p> <p>Reactions involving gain and loss of ligands: ligand dissociation and substitution, oxidative addition, reductive elimination, nucleophilic displacement, reactions involving modification of ligands: insertion, carbonyl insertion, 1-2 insertion, hydride elimination, abstraction, organometallic catalysis: Hydroformylation, Monsanto acetic acid process, Wacker Process, Hydrogenation by Wilkinson's catalyst, Olefin metathesis, heterogeneous catalysis: Ziegler Natta Polymerization, Water gas reduction.</p>	08
III	<p>Coordination Compounds: Reactions and Mechanism</p> <p>History and principles, Substitution reactions: Inert and labile complexes, mechanism of substitution, Kinetics Consequences of reaction pathway: dissociation, interchange, association, Experimental evidences in Octahedral Substitution: dissociation, linear free energy relationship, associative mechanism, the conjugate base mechanism, the kinetic chelate effect, Stereochemistry of reactions: substitution in trans complexes, substitution in cis complexes, isomerization of chelate rings, substitution reactions in Square Planer Complexes.</p>	10

Reference Books:

1. Inorganic Chemistry: Gary Miessler and Donald A. Tarr, Third Ed., Pearson (Chapter-12, 13 and 14 pages: 422 to 561)
2. IUPAC Nomenclature of Organometallic Compounds of Transition Metals by Salzer.



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Abeda Inamdar Senior College

Of Arts, Science and Commerce, Camp, Pune-1

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	CHP-125: Physical Chemistry Practical – II
Course Code	21SMCH125
Semester	II
No. of Credits	2 Credits (48 L, 12T)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	Student should understand and learn principle and working of conductometer, polarograph, potentiometer and polarimeter.
2.	Student should understand and learn standard operating procedures, calibration and application of all these instruments.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	Student will have understanding of principle and working of conductometer, polarograph, potentiometer and polarimeter.
2.	Student will have sufficient exposure in independent handling of instruments, calibration and collection of data and readings from these instruments.
3.	Student will have conceptual understanding of experimental applications, formulae and calculations.

Syllabus for CHP-125: Physical Chemistry Practical – II

Unit No.	Title with Contents	Practical Sessions
I	Conductometry (Any four): <ol style="list-style-type: none"> Hydrolysis of NH_4Cl or CH_3COONa or aniline hydrochloride. Determination of λ_0 or λ_α and dissociation constant of acetic acid. Hydrolysis of ethyl acetate by NaOH. Determination of ΔG, ΔH, and ΔS of silver benzoate by conductometry. Determination of critical micellar concentration (CMC) and ΔG of micellization of sodium Lauryl Sulphate / Detergent. 	04
II	Polarography (Any one): <ol style="list-style-type: none"> Determination of half wave potential $E_{1/2}$ and unknown concentration of Cu or Pb or Zn ion. Amperometric titration of $\text{Pb}(\text{NO}_3)_2$ with $\text{K}_2\text{Cr}_2\text{O}_7$. 	01
III	Potentiometry (Any three): <ol style="list-style-type: none"> Stability Constant of a complex ion. Solubility of a sparingly soluble salt. To determine the ionic product of H_2O. Estimation of halide in mixture. 	03
IV	Polarimetry (Any two): <ol style="list-style-type: none"> To study the rate equation for the muta-rotation of D-glucose in water. Determination the percentage of two optically active substances in a mixture by polarimetry. To study the inversion of cane sugar by polarimetry. 	02
V	Table Work (Any two): <ol style="list-style-type: none"> Analysis of powder XRD of SrTiO_3 and Ag metal or any two compounds (Calculation, lattice constant, crystal volume and density, and assigning planes to peaks using JCPDS data). Cyclic voltammogram of $\text{K}_3\text{Fe}(\text{CN})_6$ in $\text{KCl} / \text{H}_2\text{O} / \text{Ferrocene}$ in TEAP/MeCN. 	02

	3. Detailed interpretation of Raman spectra of diatomic molecules.	
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Reference Books:

1. Practical physical chemistry, A. Findlay, T. A. Kitchner (Longmans, Green and Co.).
2. Experiments in Physical Chemistry, J.M. Wilson, K. J. Newcombe, A. R. Denko. R. M. W. Richett.
3. Senior Practical Physical Chemistry, B.D. Khosla and V. S. Garg (R. Chand and Co., Delhi.).
4. Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill, 1983.
5. Advanced Experimental Chemistry, Vol. I Physical by Gurtu & R. Kapoor, S Chand & Co.
6. Systematic Experimental Physical Chemistry by S. W. Rajbhoj and T K Chondhekar, Anjali Publication.



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Abeda Inamdar Senior College

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NAAC accredited 'A' Grade

Course/ Paper Title	CHI-126: Inorganic Chemistry Practical – II
Course Code	21SMCH126
Semester	II
No. of Credits	2 Credits (48 L, 12T)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	Student should understand and learn pre-requisite & basic steps, involved in the Ore and Alloy analysis.
2.	Student should understand and learn the practical aspects of synthesis of co-ordination compounds to that of the theory.

3.	Students are expected to learn and develop basic idea of the characterization of compound based on the mentioned characterization techniques.
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Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	Students will get acquainted with basic principle of metal ions extraction techniques from a mixture
2.	Students will understand and apply theoretical aspects in the synthesis of complex formation and their stability constant by mentioned techniques

Syllabus for CHI-126: Inorganic Chemistry Practical – II

(Total 12 practical to be conducted)

Unit No.	Title with Contents	Practical Sessions
I	<ol style="list-style-type: none"> 1. Determination of iron and chromium from stainless steel alloy. 2. Determination of tin and lead from solder alloy. 3. Synthesis and Purity of Potassium tri-oxalato aluminate. 4. Synthesis and Purity of Tris (ethylene di ammine) Ni(II) thiosulphate. 5. To study complex formation between Fe(III) with sulfosalicylic acid by conductometry. 6. To verify the Debye Huckel theory of ionic conductance for strong electrolytes KCl, BaCl₂, K₂SO₄ and [K₃Fe(CN)₆]. 7. Determination of equilibrium constant of M – L systems Fe(III)– Sulphosalicylic acid or Fe(III)–β–resorcilic acid by Job’s continuous variation method. 8. Determination of equilibrium constant of M – L systems Fe (III)– Salicylic acid or by Job’s continuous variation method. 9. Determination of Cu(II) by solvent extraction as Dithiocarbamate 	12

	<p>complex.</p> <p>10. Determination of iron by solvent extraction techniques in a mixture of Fe(III) +Al(III) or Fe(III) + Ni(III) using 8-hydroxyquinoline reagent.</p> <p>11. Solution state preparation of $[\text{Ni}(\text{en})_3]\text{S}_2\text{O}_3$, $[\text{Ni}(\text{H}_2\text{O})_6]\text{Cl}_2$, $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$. Record absorption spectra in solution of all three complexes and calculate $10Dq$. Arrange three ligands according to their increasing strength depending on your observations.</p> <p>12. Estimation of hyperfine splitting pattern for the given ESR spectrum. (Any two compound).</p> <p>13. Data analysis of XRD or CV spectrum (any two compounds).</p> <p>14. Determination of magnetic susceptibility (χ_g and χ_m) of mercury tetracyanato cobalt or Fe (acac)₃ or Ferrous ammonium sulfate by Faraday or Gouy Method.</p>	
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Reference Books:

1. Vogel's Textbook of Inorganic quantitative analysis.
2. Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horwood Publishing, Chichester) 1999.
3. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House.
4. General Chemistry Experiments, Anil. J Elias, University Press (2002).
5. Practical physical Chemistry, B. Vishwanathan and P. S. Raghwan, Viva Books.
6. Physical methods in Inorganic chemistry, R. S. Drago.



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Abeda Inamdar Senior College

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NAAC accredited 'A' Grade

Course/ Paper Title	CHO-127: Organic Chemistry Practical – II
Course Code	21SMCH127
Semester	II
No. of Credits	2 Credits (48 L, 12T)

Aims & Objectives of the Course

Sr. No.	Objectives
	Student should understand and learn;
1.	The difference between traditional synthesis and green synthesis.
2.	Student should understand and learn concept of green synthesis and its principle.
3.	The selection and differences of procedures used for synthesis.
4.	The practical skill and hands skill during practical.
5.	To interpret spectral data of reactant and products.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	Students will be able to carry out laboratory scale synthesis with proper safety measures, glassware set-up, handling of hazardous chemicals, and following the prescribed experimental procedures.
2.	Students will be able to realize the importance of recording observations in laboratory notebook, which includes clear descriptions of original data, observations and experimental procedures and workup protocols.
3.	Students will be able to adapt to the requirement of green chemistry approaches.
4.	Students will be able to interpret spectral data and other observations.

Syllabus for CHO-127: Organic Chemistry Practical – II

Unit No.	Title with Contents	Practical Sessions
I	<p>Organic Preparations (Any 05 Experiments):</p> <ol style="list-style-type: none"> 1. Benzilic acid from Benzil (Benzilic acid rearrangement) 2. Benzanilide from Benzophenone by Beckmann rearrangement 3. Anthranilic acid from Phthalimide (Hoffmann rearrangement) 4. p-Nitrobenzyl cyanide from Benzyl cyanide (Nitration) 5. Hydantoin from Benzil 6. Coumarin synthesis 7. p-chloro benzyl alcohol from p-chloro benzaldehyde (NaBH₄ reduction) 	05
II	<p>Introduction to Green Chemistry (Compulsory Practical):</p> <p>Concept of green chemistry, twelve principals of green chemistry, applications of green chemistry for sustainable development, Atom economy, monitoring of reaction using TLC.</p>	01
III	<p>Green Chemistry Experiments (Any 05 Experiments):</p> <ol style="list-style-type: none"> 1. Preparation of acetanilide from aniline and acetic acid using Zn dust. 2. Base catalyzed aldol condensation using LiOH.H₂O as a Catalyst. 3. Bromination of trans-stilbene using sodium bromide and sodium bromate. 4. Benzil-Benzilic acid rearrangement under solvent free condition 5. Solid state synthesis of 7-hydroxy-4-methylcoumarin. 6. Bromination of acetanilide using ceric ammonium nitrate in aqueous medium. 7. Green approach for preparation of benzopinacolone from bezopinacol. 8. Ecofriendly nitration of phenols and its derivatives using Calcium nitrate. 	05
IV	<p>To interpret the UV, FT-IR & ¹H-NMR, CMR spectra (Any two of the above synthesized compounds).</p>	01

Reference Books:

1. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Agarwal.
2. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST

Dr. Khursheed Ahmed
BoS Chairman Chemistry
and Head, Department of Chemistry.