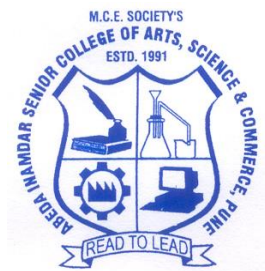


**M.C.E. Society's
Abeda Inamdar Senior College of Arts, Science and
Commerce, Pune 411 001 (Autonomous)**



**New Syllabus as per NEP-2020
for**

**M.Sc. I Analytical Chemistry
M.Sc. I Organic Chemistry**

[2026 pattern]

From Academic Year 2026-27

**Board of Studies (Chemistry)
Post Graduate Department of Chemistry and Research Center
Abeda Inamdar Senior College of Arts, Science and Commerce,
Pune-411001**

Structure of M.Sc. I Analytical Chemistry M.Sc. I Organic Chemistry

Structure of the Course:

Basic structure (Framework) of the proposed syllabus for the two-year M.Sc. (Analytical and Organic Chemistry) in the Abeda Inamdar Senior College, Pune (Autonomous) affiliated to Savitribai Phule Pune University, Pune as per NEP-2020 pattern.

Semester wise credit distribution for two-year PG Programme after three-year B.Sc.

Sem	Mandatory	Elective	RM	FP/OJT	RP	Total
I	08 (T) + 06 (P)	04 (T)	04	--	--	22
II	08 (T) + 06 (P)	04 (T)	--	04	--	22
III	10 (T) + 04 (P)	04 (T)	--	--	04	22
IV	10 (T) + 02 (P)	04 (T)	--	--	06	22
Total	36 (T) + 18 (P)	16 (T)	04	04	10	88

T = Theory Training P = Practical RM= Research Methodology, FP = Field Project, OJT = On Job Training RP= Research Project

Semester wise credit distribution for one year PG Chemistry Programme after four-year B.Sc. (B.Sc. Honors or B.Sc. (By research))

Sem	Mandatory	Elective	RM	FP/OJT	RP	Total
III	10 (T) + 04 (P)	04 (T)	--	--	04	22
IV	10 (T) + 02 (P)	04 (T)	--	--	06	22
Total	20 (T) + 06 (P)	08 (T)	--	--	10	44

Programme structure for M.Sc. I Chemistry

Sr. No.	Paper No.	Subject	Credit
SEM-I			
1	26SMCH11MM	Chemical Kinetics and reaction dynamics	02
2	26SMCH12MM	Molecular Symmetry and applications	02
3	26SMCH13MM	Basic Organic Chemistry	02
4	26SMCH14MM	Basic analytical chemistry	02
5	26SMCH15MM	Physical Chemistry Practical – I	02
6	26SMCH16MM	Inorganic Chemistry Practical – I	02
7	26SMCH17MM	Organic Chemistry Practical – I	02
(Elective: Anyone from following 26SMCH11ME)			
8	26SMCH11MEA	Chemical thermodynamics	02
8	26SMCH11MEB	Nanomaterials and applications	02
(Elective: Anyone from following 26SMCH12ME)			
9	26SMCH12MEA	Chemistry of Main Group Elements	02
9	26SMCH12MEB	Material Characterization Techniques	02
10	26SMCH11RM	Research methodology in Chemistry	04
			=22
SEM-II			
11	26SMCH21MM	Molecular Spectroscopy	02
12	26SMCH22MM	Co-ordination Chemistry	02
13	26SMCH23MM	Organic Spectroscopy & Applications	02
14	26SMCH24MM	Advanced separation techniques	02
15	26SMCH25MM	Physical Chemistry Practical – II	02
16	26SMCH26MM	Inorganic Chemistry Practical – II	02
17	26SMCH27MM	Organic Chemistry Practical – II	02
(Elective: Anyone from following 26SMCH21ME)			
18	26SMCH21MEA	Organic Reaction Mechanism – I	02
18	26SMCH21MEB	Quantum Chemistry	02
(Elective: Anyone from following 26SMCH22ME)			
19	26SMCH22MEA	Bio-inorganic Chemistry	02
19	26SMCH22MEB	Polymer chemistry	02
20	26SMCH21OJT	On Job Training (OJT)	04
			=22

***N.B.:**

1 credit theory papers = 15 Hours lectures per semester
 1 credit practical paper = 30 hours practical per semester

Programme M. Sc Organic Chemistry

Duration: 2 Years

Program Outcomes (POs)

Upon completion of M. Sc Organic Chemistry program, the students are expected to have:

PO1: Apply fundamental and advanced knowledge of chemistry in various domains (physical, organic, inorganic, analytical).

PO2: Develop analytical and problem-solving skills using scientific methods and mathematical tools.

PO3: Design, perform and interpret laboratory experiments with accuracy and safety.

PO4: Utilize modern instruments, techniques, and computational tools in chemical analysis and research.

PO5: Understand environmental, sustainability, and ethical aspects of chemical sciences.

PO6: Demonstrate research aptitude including data analysis, interpretation, and scientific writing.

PO7: Work effectively individually and in teams with professional communication skills.

PO8: Apply chemical knowledge in industry, healthcare, and societal applications.

- **Evaluation Pattern:**

For each Theory and Practical Course, 60-40 pattern will be followed. Internal assessment will be of 40 marks for a 4-credit paper of 100 Marks. Internal assessment will be of 20 marks for a 2-credit paper of 50 Marks.

For Continuous Internal Evaluation (CIE), evaluation of theory courses will be done continuously.

The 20 marks of Internal Evaluation shall be divided into the following:

- a) One Mid Semester Exams of 20 Marks each converted to 10 marks.
- b) one or two Class Tests of 15 marks each converted to 5 Marks.
- c) Class Assignments of 5 Marks. or
- d) One Presentation/Seminar/MCQ Test of 5 Marks. or
- e) One Group Discussion/Open Book Test of 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 (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

SEMESTER-I

Course/ Paper Title	Chemical Kinetics and reaction dynamics
Course Code	26SBCH11MM
Semester	I
No. of Credits	2 (30 Hours)

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;
CO1	Define and explain fundamental concepts of chemical kinetics, including rate laws, order of reactions, temperature dependence of reaction rates, and reaction mechanisms.
CO2	Analyze complex reaction mechanisms such as consecutive, parallel, chain, unimolecular, and equilibrium reactions using appropriate kinetic models and approximations.
CO3	Apply steady-state approximation, pre-equilibrium concepts, and mathematical rate expressions to solve numerical problems related to reaction kinetics.
CO4	Explain the principles and experimental techniques used in the study of fast reactions, including flash photolysis, flow methods, stopped-flow, and relaxation techniques.
CO5	Interpret molecular reaction dynamics using collision theory, activated complex theory, Eyring's equation, diffusion-controlled reactions, and ionic reaction kinetics.

PO-CO mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	1	1	1	-	2
CO2	3	3	2	2	-	2	-	2
CO3	2	3	2	2	-	2	-	2
CO4	2	2	3	3	-	2	-	2
CO5	3	2	1	2	-	2	-	2

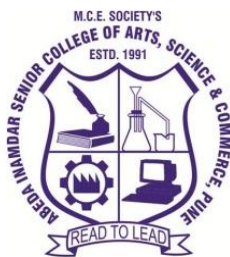
Syllabus: 26SBCH11MM: Chemical Kinetics and reaction dynamics

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.	06
III	Molecular Reaction Dynamics: Collision theory of bimolecular gas phase reactions, diffusion controlled and activation-controlled reaction solution, activated complex theory of reaction rate, Eyring's equation, reaction between ions, Primary salt effect, Problems.	07
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	07

	inhibition, Problems.	
--	-----------------------	--

Reference Books:

1. Physical Chemistry by P. W. Atkins and De Paul.
2. Physical Chemistry by T. Engel and P. Reid.
3. Principles of chemical Kinetics by James E. House.
4. Chemical Kinetics and reaction dynamics by Santosh K. Upadhyay.
5. Physical Chemistry for biological sciences by Raymond Chang (Universal books, 2000).



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Molecular Symmetry and Applications
Course Code	26SBCH12MM
Semester	VII
No. of Credits	2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
	Student should understand and learn;
1.	The concept of symmetry elements and symmetry operations, representations of symmetry groups with examples.
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.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
	Student should be able to;
CO1	Define and explain fundamental concepts of symmetry element, symmetry operation and point groups.
CO2	Analyze and Classify molecules into point group.
CO3	Apply symmetry elements and their operations as required to specify molecular symmetry to solve problems related to symmetry operations.
CO4	Explain the principles and Solve problems projection operator for constructing SALCs.
CO5	Interpret possible point groups from symmetry elements & be able to find point group of molecules by systemic procedure

CO-PO mapping for : 26SBCH12MM

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	1	-	1	-	1
CO2	3	3	-	1	-	2	-	1
CO3	3	3	-	2	-	2	-	1
CO4	2	3	-	2	-	2	-	1
CO5	3	2	-	1	-	2	-	1

Syllabus: 26SBCH12MM: Molecular Symmetry and 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, classification of molecular point groups. Defining properties of a group, group multiplication table, some examples of group, subgroups, and classes.	10
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.	08
IV	Application of Group theory to Infrared Spectroscopy:	06

	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.	
--	---	--

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



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Basic Organic Chemistry
Course Code	26SBCH13MM
Semester	I
No. of Credits	2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
Student should understand and learn	
1.	Concepts of stereochemistry and stereochemical aspects in organic chemistry
2.	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.
3.	The solve problems of rearrangement reactions, mechanism, and the stereo chemical outcomes.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
	Student should be able to;
CO1	Define and explain fundamental concepts in organic chemistry, stereochemistry, aromaticity, and reagents.
CO2	Analyze the configurations, reaction mechanisms in aromatic electrophilic substitution
CO3	Apply use of reagents, mechanisms, and aromatic application to solve problems
CO4	Explain the principles used in the study of stereochemistry, reagents, and aromaticity in organic chemistry.
CO5	Interpret the stereochemical relations, configurations, reagents, aromaticity in compounds using their concept.
CO6	Evaluate reaction mechanism by applying arenium Ion Mechanism, and assess the effects of aromaticity, use of reagents.

CO-PO mapping for : 26SBCH13MM

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	1	-	1	-	2
CO2	3	3	-	1	-	2	-	2
CO3	2	3	-	1	-	2	-	2
CO4	3	2	-	1	-	2	-	2
CO5	3	3	-	1	-	3	-	2

Syllabus

26SBCH13MM: Stereochemistry, Reagents and Rearrangements in Organic Chemistry

Unit No.	Title with Contents	No. of Lectures
I	<p>Stereochemistry:</p> <p>Recapitulation isomerism, Representation of prospective formulae and interconversion, configurational isomerism and R/S nomenclature in 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, enantiotropic and diastereotopic ligand and faces 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). Stereospecific and stereoselective reactions with examples,</p> <p>Stereochemistry and Conformational analysis monosubstituted cyclohexane, dimethyl cyclohexane, and decaline. R/S nomenclature in chair cyclohexane compounds.</p>	12
II	<p>Aromaticity and aromatic substitution reactions</p> <p>Concept of aromaticity, Aromaticity in benzenoid and non-benzenoid compounds, alternant, and non-alternant hydrocarbons. Huckel's rule, energy</p>	10

	<p>level of π-molecular orbitals, annulenes, antiaromaticity, homo-aromaticity, Craig's Rule. Application of aromaticity on Strength of organic acids and bases, dissociation:</p> <p>Aromatic electrophilic substitution — general pattern of the mechanism, The Arenium Ion Mechanism, mechanism of nitration, halogenation, sulphonation, and Friedel- Crafts reaction of benzene, naphthalene, and anthracene. Activating, deactivating substituents and their orientation and reactivity in monosubstituted and disubstituted benzene, The Ortho/Para Ratio, Ipso Attack.</p>	
III	<p>Oxidation and Reduction Reagents:</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, Wilkinson's catalyst, DIBAL and Wolff-Kishner reduction, Birch, Clemenson, Dissolving metal reduction.</p>	08

Reference Books:

1. Stereochemistry of carbon compounds - E. L. Eliel
2. Stereochemistry of carbon compounds - E. L. Eliel and S. H. Wilen
3. Stereochemistry of organic compounds - Nasipuri
4. Stereochemistry of organic compounds – Kalsi
5. Organic Chemistry—by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford)
6. Mechanism and structure in Organic Chemistry E.S. Gould
7. Advanced Organic Chemistry –by J. March 6th Edition
8. Advanced Organic Chemistry (Part A) –by A. Carey and R.J. Sundberg
9. A guidebook to mechanism in Organic Chemistry – Peter Sykes 6th Ed.
10. Modern methods of organic synthesis, W. Carrathers, Cambridge Univ. P



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

Course/ Paper Title	Basic Analytical Chemistry
Course Code	26SBCH14MM
Semester	I
No. of Credits	Credits 2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
Students will be able to:	
1.	Understand the fundamental principles, theory, and working mechanisms of chromatographic and spectroscopic techniques used in chemical analysis.
2.	Apply chromatographic and spectroscopic methods for qualitative and quantitative analysis of chemical substances in laboratory and research settings.
3.	Analyze experimental data obtained from chromatograms and spectra to identify compounds, assess purity, and determine concentrations.
4.	Evaluate the suitability and limitations of different analytical techniques for solving specific chemical and research problems.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
By the end of the course, students will be able to:	
CO1	Explain the theoretical basis and operational principles of major chromatographic techniques (Paper, TLC, Column, HPLC, GC) and spectroscopic methods (UV-Vis, IR, NMR, Mass).
CO2	Demonstrate practical competence in performing chromatographic separations and basic spectroscopic experiments, including proper sample preparation and detection.
CO3	Interpret chromatograms and spectra to identify chemical compounds, evaluate purity, and quantitatively estimate analytes.
CO4	Design and optimize analytical strategies by integrating appropriate chromatographic and spectroscopic techniques for complex chemical and research-oriented investigations.
CO5	Evaluate analytical methods

CO-PO mapping for : 26SBCH14MM

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	3	-	1	-	2
CO2	2	2	3	3	-	2	-	2
CO3	2	3	2	3	-	2	-	2
CO4	2	3	2	3	-	3	-	2
CO5	2	3	1	2	-	3	-	2

Syllabus for 26SBCH14MM: Basic analytical chemistry

Unit No.	Title with Contents	No. of Lectures
I	<p>Electroanalytical Methods</p> <p>Conductometry: Principles, equations, conductance measurement, conductometric titrations.</p> <p>Potentiometry: Principles, instrumentation, electrode potentials, Nernst equation, reference electrodes. Applications: neutralization, redox, precipitation, and complexometric titrations; end-point determination and advantages.</p> <p>pH-Metry: Principles, instrumentation, glass electrode, standard buffers, pH titrations.</p> <p>Electrogravimetry: Principles; determination of copper; separation of metal ions.</p> <p>Coulometry: Principles, methods, and coulometric titrations.</p> <p>Numerical Problems: Based on electroanalytical techniques.</p>	08
II	<p>Quantitative Calculations in Spectroscopy</p> <p>Lambert–Beer’s law: derivation, applications, and limitations</p> <p>Absorption by mixtures, Calibration curve method for determination of unknown concentrations, Spectrometric errors: instrumental and chemical deviations, Factors affecting accuracy of spectroscopic measurements, Single-beam and double-beam UV–Visible spectrophotometers: comparison and applications, Numerical problems involving concentration determination, sensitivity analysis, and deviation corrections</p>	08
III	<p>Spectroscopy – Principles, Instrumentation and Applications</p> <p>Colorimetry and UV–Visible spectroscopy, X-ray crystallography, Mass spectrometry, Atomic Absorption Spectroscopy (AAS), Numerical problems related to wavelength calibration and absorbance–concentration relationships</p>	06

IV	Introduction to Chromatographic Techniques – Principles, Instrumentation and Applications Paper chromatography, Thin Layer Chromatography (TLC), Ion Exchange Chromatography, Gas Chromatography (GC), High Performance Thin Layer Chromatography (HPTLC).	08
-----------	--	-----------

Reference Books:

1. Skoog, Holler & Crouch – Principles of Instrumental Analysis (Cengage).
2. Braithwaite & Smith – Chromatographic Methods (Blackie Academic).
3. Meyer, V.R. – Practical High-Performance Liquid Chromatography (Wiley).
4. Sharma, B.K. – Instrumental Methods of Chemical Analysis (Goel Publishing).
5. Pavia, Lampman, Kriz & Vyvyan – Introduction to Spectroscopy (Cengage).
6. Holler, Skoog & Crouch – Principles of Instrumental Analysis.
7. Willard, Merritt, Dean & Settle – Instrumental Methods of Analysis.
8. Silverstein, Webster & Kiemle – Spectrometric Identification of Organic Compounds.
9. Banwell & McCash – Fundamentals of Molecular Spectroscopy.



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Physical Chemistry Practical-I
Course Code	26SBCH15MM
Semester	I
No. of Credits	2 (60 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
	Students should understand and learn;
1.	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
	Students should be able;
CO1	Perform chemical kinetics experiments and determine reaction order, rate constants, and salt effects using experimental data.
CO2	Operate colorimetric and spectrophotometric techniques to estimate metal ions, analyze absorption spectra, and evaluate effects of solvent and conjugation on electronic transitions.
CO3	Carry out pH-metric titrations to determine dissociation constants, isoelectric points, and predict suitable indicators from titration curves.
CO4	Apply non-instrumental experimental methods to determine physicochemical parameters such as molecular weight, degree of dissociation, Van't Hoff factor, viscosity, and partial molar volumes.
CO5	Analyze experimental data using statistical tools to calculate mean, standard deviation, and construct calibration curves by least-squares method.

PO-CO mapping for 26SBCH15MM

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	3	2	-	2	1	2
CO2	2	2	3	3	-	2	1	2
CO3	2	2	3	2	-	2	1	2
CO4	2	2	3	2	-	2	1	2
CO5	2	3	2	2	-	3	1	2

Syllabus for 26SBCH15MM: Physical Chemistry Practical-I

Total 12 practical sessions to be conducted from following

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. 	04

	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.	
III	pH Metry (Any two experiments) 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 Two 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
V	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. Advanced Experimental Chemistry, Vol. I -Physical by Gurtu & R. Kapoor, S Chand & Co.
5. Systematic Experimental Physical Chemistry by S. W. Rajbhoj and T. K. Chondhekar, Anjali Publication.



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Inorganic Chemistry Practical –I
Course Code	26SBCH16MM
Semester	I
No. of Credits	2 (60 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
	Student should understand and learn;
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
	Students should be able to;
CO1	Perform ore and alloy analysis
CO2	Synthesize coordination compounds
CO3	Characterize nanoparticles
CO4	Perform ion-exchange experiments
CO5	Apply analytical techniques in inorganic chemistry

PO-CO mapping for 26SBCH16MM

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	3	2	-	2	1	2
CO2	3	2	3	2	-	2	1	2
CO3	3	2	2	3	-	2	1	2
CO4	2	2	3	2	-	2	1	2
CO5	3	3	2	2	-	3	1	2

Syllabus for 26SBCH16MM: Inorganic Chemistry Practical –I

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 alfa-Fe₂O₃ 8. 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.



M. C. E. Society's
Abeda Inamdar Senior College (Autonomous)
Of Arts, Science and Commerce, Camp, Pune-1
(Autonomous) Affiliated to Savitribai Phule Pune University
NAAC accredited 'A' Grade

Course/ Paper Title	Organic Chemistry Practical – I
Course Code	26SBCH17MM
Semester	I
No. of Credits	Credits 2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To train students in solvent drying, purification techniques, and safe laboratory practices.
2.	To develop understanding of traditional versus green synthesis, including principles of sustainable chemistry.
3.	To enhance practical and hands-on laboratory skills in organic synthesis and purification methods.
4.	To introduce students to chemical drawing applications for molecular structures and spectral prediction.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
By the end of the course,	
CO1	Synthesize and purify organic compounds
CO2	Maintain laboratory records
CO3	Apply green chemistry principles
CO4	Use software tools for structure prediction
CO5	Analyze compounds using TLC

PO-CO mapping for 26SBCH17MM

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	2	1	2	1	2
CO2	2	2	2	1	1	3	2	2
CO3	2	2	2	1	3	2	1	2
CO4	2	2	1	3	-	2	1	2
CO5	3	3	2	2	-	2	1	2

Syllabus for 26SBCH17MM: Organic Chemistry Practical – I

Total 12 practical sessions to be conducted from following

Unit No.	Title with Contents	Practical Sessions
I	Purification Techniques: 1. Thin Layer Chromatography technique 2. Column Chromatography technique.	02
II	Organic Preparations (Any 05 Experiments): 1. Benzilic acid from Benzil (Benzilic acid rearrangement) 2. Benzanilide from Benzophenone (Beckmann rearrangement) 3. Preparation of meta-Dinitrobenzene from benzene 4. Diazotisation of Anthranilic Acid. 5. Preparation of Quinone from Hydroquinone 6. Phenyl Toluene-p-sulphonate from p- toluene sulphonic chloride and phenol (Schotten-Baumann Reaction)	05
III	Green Chemistry Experiments (Any 04 Experiments): 1. Preparation of acetanilide from aniline and acetic acid using Zn dust. 2. Bromination of trans-stilbene using sodium bromide and sodium bromate. 3. Benzil-Benzilic acid rearrangement under solvent free condition 4. Solid state synthesis of 7-hydroxy-4-methylcoumarin.	04

	5. Solvent free Aldol condensation between 3,4 dimethoxybenzaldehyde and 1-indanone	
IV	Use of Chem Draw, ISIS, Marvin Sketch: Draw the structure of organic compounds, 3D structures of compounds, reaction sequence. Get the correct IUPAC name. Prediction of NMR, CMR for organic compounds	01

Reference Books:

1. Practical Organic Chemistry: Preparation, Spectroscopy and Chromatography by Frederick George Mann & Bernard Charles Saunders (updated editions)
2. Vogel's Textbook of Practical Organic Chemistry (5th Edition) by Brian S. Furniss, Antony J. Hannaford, Peter W.G. Smith, and Austin R. Tatchell.
3. Laboratory Manual of Organic Chemistry by Raj K. Bansal
4. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Chemical Thermodynamics
Course Code	26SBCH11MEA
Semester	I
No. of Credits	2 (30 Hours)

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;
CO1	Define and explain fundamental thermodynamic concepts such as state and path functions, internal energy, enthalpy, entropy, and thermodynamic potentials.
CO2	Apply laws of thermodynamics to analyze reversible and irreversible processes, entropy changes, and adiabatic expansions.
CO3	Evaluate changes of state by applying partial molar quantities, Raoult's and Henry's laws, and thermodynamic principles of mixing and colligative properties.
CO4	Derive and interpret expressions for colligative properties and solve numerical problems based on chemical potential.
CO5	Explain molecular thermodynamics using apply Boltzmann distribution, partition functions, and statistical laws to calculate thermodynamic properties.

PO-CO mapping for 26SBCH11MEA

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	1	1	1	-	2
CO2	3	3	2	2	-	2	-	2
CO3	2	3	2	2	-	2	-	2
CO4	2	2	3	3	-	2	-	2
CO5	3	2	1	2	-	2	-	2

Syllabus

26SBCH11MEA: Chemical 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.	10
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.	12
III	Molecular Thermodynamics: Molecular energy levels, Boltzmann distribution law, partition functions and ensembles, translational, rotational and vibrational partition function of diatomic molecule, obtaining energy, heat capacity, entropy and	08

	equilibrium constants from partition functions, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics, problems.	
--	--	--

Reference 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.



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Nanomaterials and Applications
Course Code	26SBCH11MEB
Semester	I
No. of Credits	2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To learn the top-down and bottom-up approach of preparing nanomaterials.
2.	To understand the physical, chemical and biological approaches of nanomaterials synthesis.
3.	To tune the morphology and functional properties by tuning the preparation parameters.
4.	To apply basic knowledge of synthesis to prepare functional and smart materials
5.	To understand the lithographic process for the fabrication of nanodevices.
6.	Encourage the Students to carryout research in nanotechnology

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
CO1	Synthesize nanomaterials using physical, chemical and biological approaches (Remember & Understand)
CO2	Tune the size and shape of the nanomaterials for diverse applications (Analyze)
CO3	Understand the functionalization of nanoparticles for specific applications (Evaluate)
CO4	Form the nanocomposites for tuning their functional properties. (Evaluate)
CO5	Understand the applications of nanomaterials in different fields (Remember)

PO-CO mapping for 26SBCH11MEB

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	3	-	1	-	2
CO2	2	2	3	3	-	2	-	2
CO3	2	3	2	3	-	2	-	2
CO4	2	3	2	3	-	3	-	2
CO5	2	3	1	2	-	3	-	2

Syllabus 26SBCH11MEB: Nanomaterials and Applications

Unit No.	Title with Contents	No. of Lectures
I	<p>Introduction: - Historical development of nanomaterials, Classification of nanomaterials</p> <p>Fundamentals of Nanomaterials- Size & Scale Units Scaling Atoms, Molecules, Clusters and Supramolecules, Structure and Bonding in Nanomaterials Chemical Bonds (types and strength) Intermolecular Forces Molecular and Crystalline Structures Hierarchical Structures Bulk to Surface transition, surface reconstruction.</p> <p>Properties and Size dependence of properties Chemical Optical, vibrational, thermal Electrical Magnetic Mechanical Theoretical Aspects-e.g. density functional theory</p>	8
II	<p>Nanomaterial Synthesis:</p> <p>Chemical routes Electrochemical methods Vapor growth Thin films methods: chemical vapor deposition, physical vapor deposition (sputtering, laser ablation), Langmuir-Blodgett growth Mechanical methods: ball milling, mechanical attrition Sol-gel methods Special nanomaterials: carbon nanotubes, fullerenes, nanowires, porous silicon Bio-inspired synthesis Nanocomposite fabrication Nanolithography</p>	8
III	<p>Nanomaterial characterization techniques:</p> <p>Scanning and Transmission Electron Microscopy Scanning Probe Microscopies: Atomic Force, scanning tunneling microscopy Diffraction and scattering techniques Vibrational spectroscopy Surface techniques</p>	8
IV	<p>Applications:</p> <p>Nano-electronics Nano optics Nanoscale chemical- and bio-sensing Biological/bio-medical applications Photovoltaic, fuel cells, batteries and</p>	6

	energy-related applications High strength nanocomposites Nanoenergetic materials,	
--	---	--

Reference Books

1. Nanomaterials- Synthesis, Properties and Applications, Edited by A.S. Edelstein and R.C. Cammarata, Institute of Physics Publishing, London, 1998 (paper back edition)
2. Nanochemistry: A Chemical Approach to Nanomaterials, by G. Ozin and A. Arsenault, RSC Publishing, 2005
3. Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Edward L. Wolf, Wiley-VCH, 2nd Reprint (2005)
4. Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Guozhong Gao, Imperial College Press, (2004).
5. Encyclopedia of Materials Characterization, C. Richard Brundle, Charles A. Evans Jr., Shaun Wilson, Butterworth - Heinemann Publishers, (1992).
6. Hand book of Microscopy for Nanotechnology, Ed. By Nan Yao and Zhong Lin Wang, Kluwer Academic Press, (2005).



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Chemistry of Main Group Elements
Course Code	26SBCH12MEA
Semester	I
No. of Credits	2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
Student should understand and learn;	
1.	The detailed chemistry of 's' and 'p' block elements with respect to their compounds, reactions and applications.
2.	Advanced chemistry of Boranes, Fullerenes, Zeolites, Carbon Nanotubes and Polymers.
3.	Advanced chemistry of PN and SN Compounds, Cage and Cluster compounds.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
Students should be able to;	
CO1	Understand main group chemistry
CO2	Explain structures and bonding
CO3	Analyze reactions of elements
CO4	Apply concepts to compounds
CO5	Interpret chemical behavior

PO-CO for 26SBCH12MEA

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	1	-	1	-	1
CO2	3	3	-	1	-	2	-	1
CO3	3	3	-	2	-	2	-	1
CO4	2	3	-	2	-	2	-	1
CO5	3	2	-	1	-	2	-	1

Syllabus

26SBCH12MEA: Chemistry of Main Group Elements

Unit No.	Title with Contents	No. of Lectures
I	Hydrogen and its compounds: Classification of Hydrides, electron deficient, electron precise and electron rich hydrides; PH ₃ , SbH ₃ , AsH ₃ Selenides, Tellurides.	03
II	Alkali and Alkaline Earth Metals: Solutions in non - aqueous media, application of crown ether in extraction of alkali and alkaline earth metal.	03
III	Boron Group: Boron Hydrides, preparation, structure and Bonding with reference to LUMO, HOMO, interconversion of lower and higher boranes, metalboranes, carboranes, reactions of organoboranes, STYX rules and structure of higher boranes.	05
IV	Carbon Group: 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.	05
V	Nitrogen Group: Nitrogen activation, Boron nitride, Oxidation states of nitrogen and their interconversion, PN and SN Compounds, Applications of PN and SN compounds.	04

VI	Oxygen Group: Metal Selenides and Tellurides, Oxyacids and Oxoanions of Sulphur and Nitrogen. Ring, Cage and Cluster compounds of p-block elements.	03
VII	Halogen Group: Interhalogens, Pseudohalogen- Synthesis, Properties and Applications; Structure, Oxyacids and Oxyanions of Halogens	03
II	Noble gases: Occurrence, Compounds of Xenon-with fluorine and Oxygen and its uses.	04

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 (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Material Characterization Techniques
Course Code	26SBCH12MEB
Semester	I
No. of Credits	2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To provide a comprehensive understanding of the principles and techniques of clinical biochemistry.
2.	To familiarize students with the applications of clinical biochemistry in disease diagnosis, monitoring, and treatment.
3.	To develop critical thinking skills for interpreting and analyzing clinical biochemistry data.
4.	To enhance students' knowledge of the biochemical processes underlying human physiology and disease.
5.	To introduce students to emerging trends and advancements in clinical biochemistry research.
6.	To cultivate practical laboratory skills relevant to clinical biochemistry techniques.
7.	To promote ethical and responsible conduct in the practice of clinical biochemistry.

Expected Course Specific Learning Outcomes

Course Outcome: Student will able to –

Sr. No.	Learning Outcome
CO1:	Students are able to understand different characterization techniques of solids

CO2:	Discuss Principle of XRD, instrumentation of powder XRD, Brags law, applications of XRD for crystal structure determination, numerical problems
CO3:	Apply their knowledge to the interpretation of SEM and TEM images.
CO4:	Differentiate between Scanning and Transmission of electron.
CO5:	Explain the basics of X-rays, the Principle of XRF, types of XRF, instrumentation, qualitative and quantitative analysis, and numerical analysis.

PO-CO mapping for 26SBCH12MEB

Syllabus

26SBCH12MEB: Material Characterization Techniques

Unit No.	Title with Contents	No. of Lectures
I	<p>X-Ray Diffraction Methods</p> <p>Miller and Weiss indices, X-Ray Radiation, Generation of X-Rays, X-Ray Absorption, Theoretical Background of Diffraction, Diffraction Geometry, Bragg's Law, Reciprocal Lattice, Diffraction Intensity, Structure Extinction, X-Ray Diffractometry, Instrumentation, System Aberrations, Samples and Data Acquisition, Sample Preparation, Acquisition and Treatment of Diffraction Data, Distortions of Diffraction Spectra, Crystallite Size, Applications, Crystal-Phase Identification, Quantitative Measurement , Wide-Angle X-Ray Diffraction and Scattering, Wide-Angle Diffraction, Wide-Angle Scattering. Problem on XRD (Calculation of d values, assigning planes, calculation of crystal parameters)</p>	8
II	<p>Transmission Electron Microscopy</p> <p>Instrumentation, Electron Sources, Thermionic Emission Gun, Field Emission Gun, Electromagnetic Lenses, Specimen Stage, Specimen Preparation, Prethinning, Final Thinning, Electrolytic Thinning, Ultramicrotomy, Image Modes (Mass–Density Contrast, Diffraction</p>	6

	Contrast, Phase Contrast), Selected-Area Diffraction (SAD), Selected-Area Diffraction Characteristics.	
III	Scanning Electron Microscopy Instrumentation, Optical Arrangement, Signal Detection, Detector, Probe Size and Current Contrast Formation, Electron–Specimen Interactions, Topographic Contrast, Compositional Contrast, Operational Variables, Working Distance and Aperture Size, Acceleration Voltage and Probe Current, Astigmatism, Specimen Preparation, Preparation for Topographic examination.	6
IV	X-Ray Spectroscopy for Elemental Analysis Features of Characteristic X-Rays, Types of characteristic X-Rays, Selection Rules, Comparison of K, L, and M Series, X-Ray Fluorescence Spectrometry, Wavelength Dispersive Spectroscopy, Analysing Crystal, Wavelength Dispersive Spectra, Energy Dispersive Spectroscopy, Detector, Energy Dispersive Spectra, Advances in Energy, Dispersive Spectroscopy, XRF Working Atmosphere and Sample Preparation, Energy Dispersive Spectroscopy in Electron Microscopes, Special Features, Scanning Modes, Qualitative and Quantitative Analysis, Qualitative Analysis, Quantitative Analysis, Quantitative Analysis by X-Ray Fluorescence, Fundamental Parameter Method, Quantitative Analysis in Electron Microscopy, Numerical.	10

Reference Books:

1. Elaine A. Moore, Lesley E. Smart - Solid State Chemistry - an Introduction. Fourth Ed. CRC Press (2012)
2. YangLeng, Materials Characterization -Introduction to Microscopic and Spectroscopic Methods, Second Ed. Wiley-VCH,
3. R. D. Braun, Introduction to Instrumental Analysis, Second Ed.



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Research Methodology in Chemistry
Course Code	26SBCH11RM
Semester	I
No. of Credits	4 (60 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
At the end of this course, the students should be able to:	
1.	understand some basic concepts of research and its methodologies
2.	identify appropriate research topics
3.	select and define appropriate research problem and parameters
4.	prepare a project proposal (to undertake a project)
5.	organize and conduct research (advanced project) in a more appropriate manner
6.	write a research report and thesis.

Sr. No.	Learning Outcome
CO-1	Minimize the risk of injury or illness to laboratory workers by ensuring that they have the training, information,
CO-2	Able to write a proposal for research design, research funding,
CO-3	Demonstrate a basic understanding of computer hardware and software; working knowledge of MS Word,
CO-4	Use databases such as SciFinder, Scopus and Cambridge structure database.
CO-5	Use able to Literature search technique
CO-6	Understand data analysis as per IUPAC and association of analytical chemist's (AOAC).
CO-7	Develop skills for systematic, articulate, and orderly presentation of research work in a written form containing

Syllabus
26SBCH11RM: Research methodology in Chemistry

Unit No.	Title with Contents	No. of Lectures
I	<p>Introduction to Research methodology: Objective of research, motivation in research, types of research, Fundamental research, applied research, experimental research, interdisciplinary research, scientific methods of research, criteria of good research, and characteristics of a good research.</p>	04
II	<p>Scope of Research and Ethics: Steps in scientific research: Introduction and Scope, Research problem: Identification, Selection, developing research title, Criteria for prioritizing topics for research, Prioritizing Topics for Research, Formulation of research objectives Research design: Components, Types and importance Research ethics, Institutional ethics committee, Plagiarism, Patenting and intellectual property rights.</p>	05
III	<p>Processes in research proposal development: Components of research proposal- Components of research proposal: 1. Title page 2. Summary/Abstract 3. Introduction/background 4. Statement of the problem 5. Literature review 6. Hypotheses/questions 7. Conceptual framework 8. Objective/aim of the study 9. Research methods, material, and procedure 10. Work plan 11. Budget 12. References 13. Appendices/annexes.</p>	08
IV	<p>Literature search technique: using SCOPUS, Google Scholar, PUBMED, Web of Science, science direct, Indian Citation Index, Research Gate, and scifinder. Overview of the journal article: Selection of journals, Data bases and research metrics Databases: 1. Indexing databases 2. Citation databases: Web of Science, Scopus, UGC-Care List etc. Research Metrics: 1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score 2. Metrics: h-index, g index, i10 index etc</p>	06
V	<p>Presentation of Scientific findings, Scientific Report Writing: Publication Process: Types of technical documents- Full length research paper, Short/Brief communications, Letters to editor, Book chapter, Review, Conference report, Patents, dissertation. Components of a research publication: Title/Topic statement, Abstract/key words, Aims and objectives, Hypothesis building, Rationale of the paper,</p>	08

	<p>Work plan, Materials and methodology, Results and discussion, Key issues and arguments, Acknowledgement, Conflict of interest statement, bibliography, Technical Resumes & Cover Letters.</p> <p>Softwares in Chemistry Data plotting Structure Drawing, Grammar Checkers and Sentence Correction Tools.</p>	
VI	<p>Scientometrics:</p> <p>How to cite and how to do referencing</p> <p>Styles of referencing: APA, MLA, Oxford, Harvard, Chicago</p> <p>Annotated bibliography; Tools for citing and referencing: Grammarly, Endnote etc.,</p> <p>Reference Management Software like Zotero, Mendeley, reference manager and others; Software for paper formatting like LaTeX/MSOffice, software for detection of Plagiarism</p>	05
VII	<p>Data Analysis and interpretation:</p> <p>Chemometrics. Analysis of variance (ANOVA), Measures of central tendency and dispersion - mean, median, mode, range, standard deviation, variance. Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, r and its abuse. Basic aspects of multiple linear regression analysis. Types of errors and level of significance. Tests of significance – F & t tests, chi-square tests,</p>	06
II	<p>Publications Ethics:</p> <p>definition, nature of moral judgements and reactions, Ethics with respect to science and research. Intellectual honesty and research integrity.</p> <p>Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP).</p> <p>Redundant publications: duplicate and overlapping publications. Selective reporting and misrepresentation of data.</p> <p>Publication ethics: definition, introduction, and importance.</p> <p>Conflicts of interest Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa Violation of publication ethics, authorship and contributorship Identification of publication misconduct, complaints and appeals Predatory publishers and journals.</p>	04
IX	<p>Presentation and Communication skills:</p> <p>Tables, Figures and Pictures using Excel, PowerPoint slide preparation, Preparation of Posters, Electronic submission of manuscripts, oral and poster, Communication skills.</p>	04
X	<p>Chemistry Laboratory Practices:</p> <p>Safety practices in Chemical research: Safety aspects in Chemistry Good laboratory practices. Handling of various chemicals, solvents & glassware. Fires and fighting with fires. Hazardous substances, classification, and handling Safety Data Sheet.</p>	10

	<p>Chemical entries, MSDS, CAS numbers, dead stocks maintenance.</p> <p>Working conditions and equipment: cleaning and washing of required glassware, calibration of equipment, set up chemical reactions, condition, optimization of conditions- temperature, solvent, catalysis; equipment SOP, maintenance and repairing, waste managements.</p> <p>Maintaining data and observations- importance of recording observations in research laboratory notebook, which includes clear descriptions of original data, observations and experimental procedures and workup protocols, group discussion, discussion with guides, weekly/monthly/six monthly presentation of research progress.</p>	
--	--	--

Reference book:

1. Best and Kahn, Research Methodology, PHI Limited.
- 2) Kothari, C. K., Research Methodology-Methods and Techniques, 2nd Ed., New Age International, New Delhi.
- 3) Kumar, R., Research Methodology - A Step-By-Step Guide for Beginners, Pearson Education, Delhi (2006).
- 4) Fundamentals of modern statistical methods by Rand R.wilcox.
- 5) Power Analysis for Experimental research A Practical Guide for the Biological, Medical and social Sciences by R. Barker Bausell, Yi-Fang Li Cambridge University Press.
- 6) Design of Experience: Statistical Principles of Research Design and Analysis, by Robert O. Kuehl Brooks/cole.
- 7) Panneerselvam R., Research Methodology, Prentice Hall of India, New Delhi,2004
- 8) Montgomery, D. C., Design & Analysis of Experiments, 5th Ed., Wiley India (2007).

Semester II



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Molecular Spectroscopy
Course Code	26SBCH21MM
Semester	II
No. of Credits	2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
	Students should;
1.	Student should understand fundamentals of molecular spectroscopy.
2.	To correlate classical and quantum approach in spectroscopic methods.
3.	Learn about rotational spectroscopy and the rigid rotator model to describe a rotating diatomic molecule.
4.	Student should able to solve numerical problems based on various spectroscopic methods.
5.	Student should understand the application of spectroscopic methods and their relevance.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
	Student should be able to;
CO1	Define and explain the characteristics of electromagnetic radiation, quantization of energy, and factors affecting width and intensity of spectral transitions.
CO2	Explain the principles of microwave spectroscopy and analyze rotational spectra of di- and polyatomic molecules based on molecular structure.
CO3	Apply infrared spectroscopic principles to interpret vibrational and rotational-vibrational spectra of diatomic and polyatomic molecules.

CO4	Explain Raman spectroscopy using quantum and classical theories and analyze rotational and vibrational Raman spectra for molecular structure determination.
CO5	Interpret electronic spectra of molecules by applying the Born–Oppenheimer approximation, Franck–Condon principle, and fine-structure analysis. Analyze molecular electronic transitions to evaluate dissociation energies, predissociation phenomena, and photoelectron spectra.

PO-CO mapping for 26SBCH21MM

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	1	1	1	-	2
CO2	3	3	2	2	-	2	-	2
CO3	2	3	2	2	-	2	-	2
CO4	2	2	3	3	-	2	-	2
CO5	3	2	1	2	-	2	-	2

Syllabus 26SBCH21MM: 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.	06
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	08

	polyatomic molecule, Fourier transform spectroscopy and its advantages, The carbon dioxide laser, Applications, problems.	
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.	07
V	Electronic Spectroscopy of molecules: Electronic spectra of diatomic molecules - The Born- Oppenheimer approximation, Vibrational coarse structure, Frank- Condon principle, dissociation energy and dissociation product, Rotational fine structure of electronic-vibration transition, The fortrat diagram, Pre-dissociation, molecular photoelectron spectroscopy, problems.	06

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.



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Co-ordination Chemistry
Course Code	26SBCH22MM
Semester	II
No. of Credits	2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
Student should understand and learn;	
1.	The concepts of metal ligand bonding in transition metal complexes.
2.	The ligand field effect, R-S terms in coordination complex.
3.	The concepts of microstate tables and Orgel diagrams.
4.	Analysis of electronic spectra and magnetic properties of transition metal complexes.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
Students should be able to;	
CO1	Define symmetry elements and operations
CO2	Classify molecules into point groups
CO3	Apply symmetry operations
CO4	Solve problems using SALCs
CO5	: Interpret molecular symmetry

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	1	-	1	-	1
CO2	3	3	-	1	-	2	-	1
CO3	3	3	-	2	-	2	-	1
CO4	2	3	-	2	-	2	-	1
CO5	3	2	-	1	-	2	-	1

Syllabus
26SBCH22MM: Co-ordination 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.	07
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 1st, 2nd and 3rd 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.	08
IV	Magnetic Properties of Coordination Complexes: Origin magnetism, types of magnetism, Curie law, Curie-Weiss Law, Magnetic properties of complexes, Para magnetism, 1st and 2nd order Zeeman effect, quenching of orbital angular momentum by Ligand fields,	08

	Magnetic properties of A, E and T ground terms in complexes, spin free and spin paired equilibria, temperature dependence of magnetism.	
--	---	--

Reference Books:

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



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Organic Spectroscopy
Course Code	26SBCH23MM
Semester	II
No. of Credits	Credits 2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To understand the fundamental principles of various spectroscopic techniques used in organic chemistry.
2.	To study UV, IR, NMR, and CMR methods and apply them to structure determination.
3.	To develop the ability to interpret and deduce organic structures from spectral data.
4.	To integrate multiple spectroscopic methods for problem-solving in organic structure elucidation.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
By the end of the course	
CO1	Students will demonstrate knowledge of basic principles of UV, IR, NMR, and CMR spectroscopy.
CO2	Students will be able to elucidate organic compound structures using spectral data and spectra.
CO3	Students will explain key factors influencing spectroscopic data acquisition and interpretation.
CO4	Explain stereochemical principles
CO5	Students will solve structural problems using combined spectroscopic data (UV, IR, MS, ¹ H-NMR, ¹³ C-NMR).

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	1	-	1	-	2
CO2	3	3	-	1	-	2	-	2
CO3	2	3	-	1	-	2	-	2
CO4	3	2	-	1	-	2	-	2
CO5	3	3	-	1	-	3	-	2

Syllabus for 26SBCH23MM: Organic Spectroscopy

Unit No.	Title with Contents	No. of Lectures
I	UV spectroscopy: Recapitulation of UV spectroscopy- Introduction and principles of electronic transitions. Absorption shifts and solvent effects. Application of Woodward–Fieser rules for calculating λ_{max} of conjugated dienes, enones, and aromatic systems.	04
II	Infrared (IR) Spectroscopy: Recapitulation of Fundamentals and instrumentation of IR spectroscopy, Vibrational modes and characteristic absorption of functional groups. Factors influencing IR frequencies: conjugation, ring strain, hydrogen bonding, inductive and resonance effects, Problem-solving based on IR spectral data.	04
III	¹H-NMR Spectroscopy: Basic principles and NMR-active nuclei, Chemical shifts and influencing factors: electronegativity, solvent polarity, temperature, anisotropy, Spin-spin coupling, multiplicity patterns, Pascal's triangle, and tree diagrams, Complex splitting in aromatic, vinylic, cyclic, and bicyclic compounds, Integration for mixture analysis, molar ratio, and enantiomeric excess (ee%) calculations.	12
IV	¹³C-NMR Spectroscopy: Introduction and principles of ¹³ C-NMR, Chemical shifts and factors affecting them, Off-resonance and proton-decoupled spectra, Examples illustrating interpretation of ¹³ C signals.	06
V	Mass Spectrometry (MS): Basic principles and instrumentation of MS, Types of mass spectra and interpretation of m/z values, Molecular ion peak (M ⁺), Rule of 13, Nitrogen rule, and isotope peaks,	04

	Applications in molecular formula determination and problem-solving using HRMS data.	
--	--	--

Reference Books:

1. Introduction to Spectroscopy – Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan
2. Spectrometric Identification of Organic Compounds – Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce
3. NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry – Harald Günther
4. Organic Spectroscopy – P. S. Kalsi
5. Organic Structures from Spectra – L.D. Field, S. Sternhell, J.R. Kalman
6. Applications of Absorption Spectroscopy of Organic Compounds – D.H. Williams & I. Fleming



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

Affiliated to Savitribai Phule Pune University, Pune

NAAC accredited 'A' Grade

Course/ Paper Title	Advanced Separation Techniques
Course Code	26SBCH24MM
Semester	II
No. of Credits	2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	Student should understand the theoretical principles and practical applications of different chromatographic and spectroscopic techniques.
2.	Student should understand and learn concepts in spectroscopy and Chromatography.
3.	Student should learn more about the qualitative/quantitative characterization and separation techniques.
4.	Students are expected to get familiarized with the techniques involving chromatography and spectroscopy.
5.	The students should learn the basics of different chromatographic and spectroscopic techniques.
6.	Student should understand and learn principle and working of analytical Instruments.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
CO1	Students will be able to learn various terminologies and concepts relevant to qualitative and quantitative aspects of analyses.
CO2	Students should be in a position to understand principle behind different analytical techniques.
CO3	Students should be in a position to select the separation techniques for purification of analytes.

CO4	Student should be able to evaluate the utility of UV/Vis spectroscopy as a qualitative and quantitative method.
CO5	With the knowledge basic techniques used for qualitative and quantitative estimation students should be in a position to choose for appropriate technique.

PO-CO mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	3	-	1	-	2
CO2	2	2	3	3	-	2	-	2
CO3	2	3	2	3	-	2	-	2
CO4	2	3	2	3	-	3	-	2
CO5	2	3	1	2	-	3	-	2

Syllabus

26SBCH24MM: Advanced separation techniques

Unit No.	Title with Contents	No. of Lectures
I	Chromatography: Principles of Chromatographic Separations, Classification of Chromatographic Techniques, Principle, instrumentation, and applications of: Paper chromatography, Thin layer chromatography (TLC), Gel permeation (size exclusion) chromatography, Ion exchange chromatography, Affinity chromatography, Gas chromatography, HPLC and HPTLC. (Ref. 1, 2)	04
II	Theoretical Aspects of Chromatography Theoretical principles - retention time, retention volume, adjusted retention time, relative retention, capacity factor. Relation between retention time and partition coefficient. Scaling up, scaling rules. Efficiency of separation, resolution. Ideal chromatographic peaks (Gaussian peak shape). Diffusion, diffusion coefficient. Plate height - Plate height as a measure of column efficiency, number of theoretical plates. Asymmetric peaks. Factors affecting resolution. Band spreading - van Deemter equation, multiple paths, longitudinal diffusion, mass transport. Isotherms and the resulting band shapes. Sample derivatization. Numerical problems based on these methods. (Ref. 1, 2, 3)	06

III	<p>Gas Chromatography:</p> <p>Principle, instrumentation and applications of Colorimetry, UV-Visible Spectroscopy and choice of source, monochromator and detector for single and double beam instrument, X-Ray Crystallography, Mass Spectrometry. Atomic Absorption Spectrometry and choice of source, monochromator, detector, choice of flame and Burner types and designs. Atomization and sample introduction, sources of chemical interferences and their method of removal. Numerical problem based on these techniques. (Ref. 1, 2)</p>	10
IV	<p>High Performance Liquid Chromatography: Theory and instrumentation of HPLC, Mobile phase delivery system, sample injection, separation column, Column: types of column packing, stationary phase, bonded stationary phases, monolithic silica columns, elution process - eluent strength, effect of eluent strength of solvent on peak symmetry. Normal phase chromatography, reversed phase chromatography - isocratic and gradient elution. Normal phase and reversed phase with special reference to types of commercially available columns (Use of C8 and C18 columns). Gradient separations: dwell volume and dwell time, developing a gradient separation. Selecting the separation mode. Injection and detection in HPLC, pumps and injection valves, Method development in HPLC, method development in reversed phase separation. Criteria for adequate separation, optimization with one organic solvent, optimization with two or three different organic solvents, temperature as a variable, choosing a stationary phase. Detectors: spectrophotometric detectors, evaporative light scattering detector. LC-MS, Nano LC-MS: overview, applications in omic</p>	10

Reference Books:

1. Christian, G. D., Analytical Chemistry, 7th Ed., Wiley India, New Delhi, 2003.
2. Harvey David, Modern analytical chemistry, The McGraw-Hill Companies, Inc., 2000
3. Analytical Chemistry, Ed. by Kellner, Mermet, Otto, Valcarcel, Widmer, 2nd Ed., Wiley
4. Skoog, D. A.; Holler F. J.; Crouch, S. R., Principles of Instrumental Analysis, 6th Ed., Cengage Learning India, New Delhi, 2014.
5. Chatwal G. R., Anand Sham K., Instrumental Methods of Chemical Analysis, 5th Edition, Himalaya Publishing House, 2005.
6. Instrumental Methods of Chemical Analysis, Dr. B. K. Sharma, Krishna Prakashan Media, 1981.



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Physical Chemistry Practical-II
Course Code	23SMCH85MM
Semester	II
No. of Credits	2 (60 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
	Students should understand and learn;
1.	Principle and working of conductometer, polarograph, potentiometer and polarimeter.
2.	Standard operating procedures, calibration and application of all these instruments.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
	Student will have;
CO1	Understanding of principle and working of conductometer, polarograph, potentiometer and polarimeter.
CO2	Sufficient exposure in independent handling of instruments, calibration and collection of data and readings from these instruments.
CO3	Conceptual understanding of experimental applications, formulae and calculations.
CO4	Determine physicochemical parameters
CO5	Analyze experimental data

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	3	2	-	2	1	2
CO2	2	2	3	3	-	2	1	2
CO3	2	2	3	2	-	2	1	2
CO4	2	2	3	2	-	2	1	2
CO5	2	3	2	2	-	3	1	2

Syllabus for 26SBCH25MM: Physical Chemistry Practical-II

Total 12 practical sessions to be conducted from following

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): 1. To study the rate equation for the muta-rotation of D-glucose in water. 2. Determination the percentage of two optically active substances in a mixture by polarimetry. 3. To study the inversion of cane sugar by polarimetry.	02
V	Table Work (Any two): 1. 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). 2. Cyclic voltammogram of K ₃ Fe(CN) ₆ in KCl / H ₂ O / Ferrocene in TEAP/MeCN. 3. Detailed interpretation of Raman spectra of diatomic molecules.	02

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.



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Inorganic Chemistry Practical –II
Course Code	26SBCH26MM
Semester	II
No. of Credits	2 (60 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
	Student should understand and learn;
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.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
	Students should be able to;
CO1	Perform ore/alloy analysis
CO2	Synthesize coordination compounds
CO3	Characterize nanoparticles
CO4	Perform ion-exchange experiments
CO5	Apply analytical techniques

PO-CO mapping

Syllabus 26SBCH26MM: Inorganic Chemistry Practical –II

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 complex.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.11. Solution state preparation of [Ni(en)₃]S₂O₃, [Ni(H₂O)₆]Cl₂, [Ni(NH₃)₆]Cl₂. Record absorption spectra in solution of all three complexes and calculate 10Dq. Arrange three ligands according to their increasing strength depending on your observations.12. Estimation of hyperfine splitting pattern for the given ESR spectrum. (Any two compound).13. Data analysis of XRD or CV spectrum (any two compounds).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.	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.
6. Physical methods in Inorganic chemistry, R. S. Drago.



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Organic Chemistry Practical – II
Course Code	26SBCH27MM
Semester	II
No. of Credits	Credits 2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To continue the study of organic chemistry principles with emphasis on functional groups such as aromatic compounds, phenols, carboxylic acids and derivatives, aldehydes, ketones, amines, and malonic ester synthesis.
2.	To train students in predicting functional group transformations, understanding simple reaction mechanisms, and designing multi-step synthesis strategies.
3.	To develop practical skills through advanced experiments including double-stage preparation and solvent-free synthesis, highlighting sustainable laboratory practices.
4.	To enhance competency in chemical drawing applications for molecular structures and reaction schemes, supporting digital integration in laboratory work.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
By the end of the course	
CO1	Students will acquire the ability to synthesize organic compounds using multi-step and solvent-free methods, and evaluate their efficiency.
CO2	Students will gain proficiency in observing, recording, and analyzing experimental data with accuracy and clarity in laboratory notebooks.
CO3	Students will demonstrate safe and effective use of laboratory equipment, chemicals, and techniques during advanced organic preparations.
CO4	Students will be able to draw and interpret molecular structures using chemistry drawing software, and connect these with reaction mechanisms and synthesis pathways.
CO5	Analyze compounds

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	2	1	2	1	2
CO2	2	2	2	1	1	3	2	2
CO3	2	2	2	1	3	2	1	2
CO4	2	2	1	3	-	2	1	2
CO5	3	3	2	2	-	2	1	2

Syllabus for 26SBCH27MM: Organic Chemistry Practical – II

Unit No.	Title with Contents	No. of Lectures
I	<p>Double stages preparation (any three preparations). The preparations should be carried out on microscale.</p> <p>1. Benzaldehyde ----- Benzalacetophenone ----- Epoxide 2. Cyclohexanone ----- Phenyl hydrazine ----- 1, 2, 3, 4-tetrahydrocarbazole 3. Benzoin ----- Benzil ----- Quinoxaline 4. Phthalic acid ----- Phthalimide----- Anthranilic acid 5. Benzyl cyanide----- p-Nitrobenzyl cyanide ----- p-Nitro phenyl acetic acid</p>	06
II	<p>Solvent free synthesis (Any six Experiments)</p> <p>1. Preparation of benzylidene malonitrile from benzaldehyde 2. Preparation of 3-carboxycoumarin from Salicylaldehyde and Meldrum's acid by using ammonium acetate (Knoevenagel condensation) 3. Pechmann reaction 4. Azomethine synthesis 5. Claisen reaction 6. Reformatsky reaction/Luche reaction 7. Dieckmann condensation</p>	06

Reference Books:

1. Vogel, A. I. Vogel's Textbook of Practical Organic Chemistry, 5th Edition, Longman Scientific & Technical.
2. Furniss, B. S.; Hannaford, A. J.; Smith, P. W. G.; Tatchell, A. R. Vogel's Textbook of Practical Organic Chemistry, Pearson Education.
3. Solvent-free Organic Synthesis by Koichi Tanaka (Copyright © 2009 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, ISBN: 978-3-527-32264-)
4. Additional Study Material: <https://nptel.ac.in/courses/104/106/104106108/>



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Organic Reaction Mechanism-I
Course Code	26SBCH21MEA
Semester	II
No. of Credits	2 Credits, (30 Hours)

Aims & Objectives of the Course

Objectives
1. To understand organic reactions through mechanistic pathways
2. To correlate structure, reactivity, and reaction intermediates
3. To develop analytical skills in reaction mechanism interpretation

Expected Course Specific Learning Outcomes

Learning Outcome
Student should be able to –
1. Explain nucleophilic substitution mechanisms and factors affecting them.
2. Analyse neighbouring group participation and carbocation behaviour.
3. Interpret reactions involving carbenes and free radicals.
4. Apply organometallic and ylide chemistry in reaction mechanisms.

Syllabus
26SBCH21MEA: Organic Reaction Mechanism-I

Sr. No.	Name of the Topic	Hours
1	<p>Aliphatic Nucleophilic Substitution Reactions SN₂ mechanism, SN₁ mechanism, Mixed SN₁ and SN₂ mechanisms, SET (Single Electron Transfer) mechanism, SN_i mechanism Nucleophilic substitution at: Allylic carbon, Aliphatic trigonal carbon, Vinylic carbon Factors affecting nucleophilic substitution reactions: Substrate, nucleophilicity, solvent, steric effect, hard-soft interaction, leaving group, ambident nucleophile and regioselectivity.</p>	08
2	<p>Neighboring Group Mechanism Neighboring group participation mechanism, Neighboring group participation by π-bonds, Neighboring group participation by σ-bonds, Anchimeric assistance, Classical and non-classical carbocations, Phenonium ions, Norbornyl system, Carbocation rearrangements in neighboring group participation</p>	07
3	<p>Reactions of Carbenes and Free Radicals Carbene Reactions: Reactions of halocarbenes, Photolysis of cyclopropanes, Bamford-Stevens reaction, Carbene reactions of diazoalkanes: Addition to alkenes, Addition to aromatic derivatives, Cyclization reactions of α-diazo ketones, C-H insertion reactions of α-diazo ketones, Carbenoids – Simmons-Smith reaction Free Radical Reactions: Coupling reactions, Addition reactions, Substitution reactions, Reduction reactions, Barton-McCombie reaction, Barton reaction, Intermolecular radical coupling of alkyl halides and alkenes, Intramolecular radical reactions (radical cyclization)</p>	08
4	<p>Reactions of Organometallic Compounds and Ylides Organometallic Compounds: Addition of Grignard reagents to carbonyl and unsaturated carbonyl compounds, Reactions of organolithium reagents, Reactions of organozinc reagents, Reactions of organocopper reagents Ylide reactions: Phosphorus ylides, Nitrogen ylides, Sulphur ylides</p>	07

References:

1. Advanced Organic Chemistry –by J. March 6th Edition.
2. Organic Synthesis-by Michael B. Smith Third Edition.
3. A guidebook to mechanism in organic chemistry – Peter Sykes 6th Ed. Orient Longman.
4. Mechanism and structure in Organic Chemistry – E. S. Gould (Holt, Rinehart and Winston).
5. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers. Oxford University Press (2001)



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Quantum Chemistry
Course Code	26SBCH21MEB
Semester	II
No. of Credits	2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
	Students should;
1.	Understand quantum mechanical principles as well as the different microscopic phenomena.
2.	Understand the covalent nature of bonding and their theoretical background and correlation to practical aspects.
3.	Have a sound understanding of different spectroscopic techniques and photochemistry.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
	Student should be able to;
CO1	Explain the failure of classical mechanics by describing blackbody radiation, photoelectric effect, de Broglie hypothesis, and the uncertainty principle with experimental evidence.
CO2	Apply quantum mechanical concepts to solve problems related to translational motion, particle-in-a-box models, and hydrogen-like atomic systems.
CO3	Explain the postulates of quantum mechanics and apply operator algebra, commutation relations, and differential operators to quantum mechanical problems.
CO4	Apply quantum chemical theories to analyze chemical bonding using valence bond theory, hybridization, and molecular orbital theory for simple molecular systems.

CO5	Interpret molecular orbital energy levels and evaluate bonding characteristics in π -electron systems using the linear variation and Hückel approximation methods.
------------	--

Syllabus
26SBCH21MEB: Quantum Chemistry

Unit No.	Title with Contents	No. of Lectures
I	Fundamental Background: Failure of classical mechanics: blackbody radiation, photoelectric effect, de Broglie hypothesis and uncertainty principle and its experimental evidence.	08
II	Application of Quantum Chemistry in Translation motion: Schrödinger wave equation, particle in one dimensional box, Normalization and orthogonality of wave function, particle in three-dimensional box, hydrogen like atoms (no derivation).	06
III	The Postulates and General Principles of Quantum Mechanics: Postulates of Quantum Mechanics, Operators: algebra of operators, commutative property, linear operators, commutator operator, the operator ∇ and ∇^2 , Problems.	06
IV	Chemical Bonding: 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.	10

Reference Books:

10. Physical Chemistry by P. W. Atkins and De Paul.
11. Physical Chemistry by T. Engel and P. Reid.
12. Physical Chemistry and molecular approach by D. Mequarie and J. Siman.
13. Quantum Chemistry by I. Levine.
14. Quantum Chemistry by R.K. Prasad.



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Bio-inorganic Chemistry
Course Code	26SBCH22MEA
Semester	II
No. of Credits	2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
	Student should understand and learn;
1.	The role of metal ions in biological system.
2.	The bioinorganic chemistry of hemoglobin.
3.	The bioinorganic chemistry of myoglobin.
4.	The bioinorganic chemistry of Iron in Ferritin, Transferrin, Fe-S clusters, Porphyrin based system, the role of Ca in blood coagulation.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
	Students should be able to;
1.	Students will be able to explain concept of bioinorganic chemistry.
2.	Students will be able to explain and apply HSAB rule chelation, macro cyclic, cryptate effect.
3.	Students will be able to explain functions and transport of Alkali and Alkaline Earth Metal ions.
4	Students will be able to explain the role of Ca in blood coagulation, role of iron in Ferritin and Transferrin. Students will be able to understand the structures of Fe-S clusters, Porphyrin based system

Syllabus
26SBCH22MEA: 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>	11
II	<p>Concepts of Inorganic Chemistry in Bioinorganic Chemistry:</p> <p>Thermodynamic aspects - HSAB concept, chelate effect and IrvingWilliam 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>	10
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>	05
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 38
2. Bioinorganic Chemistry: Inorganic Elements in Chemistry of Life by W. Kaim and B. Schwederski
3. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S. J. Lippard and J.S. Valentine.
4. Inorganic Biochemistry, G. L. Eichhorn, vol. I and II., Elsevier.
5. Progress in Inorganic Chemistry, Vols. 18 and 38, S. J. Lippard, Eiley.



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	Advanced Polymer Chemistry
Course Code	26SBCH22MEB
Semester	II
No. of Credits	2 (30 Hours)

Aims & Objectives of the Course

Sr. No.	Objectives
1.	To provide a solid foundation in the fundamental principles of molecular and cell biology.
2.	To familiarize students with the molecular mechanisms underlying cellular processes and functions.
3.	To explore the interdisciplinary aspects of molecular biology and its relevance to chemistry.
4.	To develop critical thinking and analytical skills for understanding and interpreting molecular and cell biology research.
5.	To introduce students to emerging topics and technologies in molecular and cell biology.

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1.	Demonstrate a thorough understanding of the principles and mechanisms of molecular and cell biology.
2.	Explain the molecular processes underlying cellular functions, including DNA replication, gene expression, and protein synthesis.
3.	Analyze and interpret molecular and cell biology research findings, critically evaluating experimental data and scientific literature.
4.	Apply chemical principles to understand and investigate biochemical pathways and drug targets.
5.	Perform molecular and cell biology techniques accurately and safely in a laboratory setting.
6.	Communicate effectively about molecular and cell biology concepts, research findings, and ethical considerations.

Syllabus
26SBCH22MEB: Advanced Polymer Chemistry

Unit No.	Title with Contents	No. of Lectures
I	<p>Basic Concepts of Polymers: Introduction – Monomer, oligomer, Polymer and Polymerizations, Functionality, repeating units Nomenclature of polymers, classification of polymers based on sources, method of polymerization, Intermolecular forces and their properties.</p> <p>Raw materials for monomers with specific example viz. acrylonitrile, vinyl, chloride, methyl methacrylate, isobutylene, isoprene, styrene, hexamethylene diamine and adipic acid, caprolactum, ethylene oxide and sebasic acid, ethylene glycol and terephthalic acid and their Polymerization reactions. Preparation, structure, properties, and applications of the following polymers: polyolefins (polyethylene, polypropylene), polystyrene, polyvinyl chloride, polyvinyl acetate, polyacrylamide, fluoro polymers (Teflon), polyamides (nylon-6 and nylon 6, 6). Thermosetting polymers - phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, conducting polymers (polyacetylene, polyaniline). Brief outline of biodegradable polymers.</p>	10
II	<p>LIQUID CRYSTALLINE POLYMERS (LCPS): Concept of liquid crystalline (LC) phase, liquid crystalline polymers and their classification, applications of LCPs.</p> <p>CONDUCTING POLYMERS Theory of conduction, band theory, requirements for polymer to work as conductor, types of conducting polymers - doping of polymeric systems, Polyaniline, Polyacetylene, Polypyrrole, organometallic polymers – Photo conducting polymers- Polymers with Piezo, ferro and pyro electric properties.</p> <p>HEAT RESISTANT POLYMERS Requirements for heat resistance, determination of heat resistance, synthesis, structure-propertyrelationships, applications of heat-resistant polymers like polyamides, polyimides</p>	10
III	<p>PHOTOSENSITIVE POLYMERS AND POLYMERS AS COATING ADDITIVES: Photosensitive polymers - synthesis, curing reactions, applications in various fields. Photo resist for semiconductor fabrication. Membranes, their types, methods of casting and their applications. Polymer as coating additives - types, synthesis, requirements for polymer to work as coating additives and applications</p>	10

Reference Books:

- 1) F.W. Billmeyer, Jr. Textbook of polymer science, Wiley- Interscience, N.Y. (1971)
- 2) Introduction to polymer chemistry, R. Seymour, Wiley –Interscience (1981)
- 3) Principles of polymer chemistry by P.J.Flory.

4) Polymer Science –V RGowarikar.

5) Polymer Chemistry, by Seymour R. B. and Carraher, Marcel Dekker (2000).



M. C. E. Society's

Abeda Inamdar Senior College (Autonomous)

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

(Autonomous) Affiliated to Savitribai Phule Pune University

NAAC accredited 'A' Grade

Course/ Paper Title	On Job training (OJT)
Course Code	26SBCH21OJT
Semester	<i>II</i>
No. of Credits	4

The students, as a part of their course, will be given opportunities to enroll for Field Project(s) or on job training.

The student must undergo field work project which related to chemistry.

The students must undergo industrial on job training/internship in the 8th semester in any of the reputed industry, Government-sponsored Research & Development Organization, and reputed academic institution/foreign universities.

In a fieldwork report or On Job training, it is important to include relevant information and observations in following format.

- Introduction:
- Methodology:
- Fieldwork Activities:
- Data Collection:
- Findings, data analysis and Results:
- Discussion:
- Recommendations:
- Conclusion:
- References:
- Supplementary material

In a report on job training, it is important to provide a comprehensive overview of the training program and highlight key learnings and outcomes.

some points to consider when creating a report on job training:

- Introduction:
- Training Program Overview:
- Learning Objectives:
- Training Activities:
- Skills and Knowledge Acquired:
- Challenges and Solutions:
- Feedback and Evaluation:
- Impact and Benefits:
- Recommendations:
- Conclusion: