M. C. E. Society's
Abeda Inamdar Senior College
Of Arts, Science and Commerce, Camp, Pune-411001
(Autonomous) Affiliated to Savitribai Phule Pune University
NAAC accredited 'A' Grade

National Education Policy NEP-2020

From Academic Year 2025-26

Syllabus for Third Year Bachelor of Science (T.Y. B. Sc.)

Chemistry Major

Board of Studies (Chemistry)

Post Graduate Department of Chemistry and Research Centre

Abeda Inamdar Senior College of Arts, Science and Commerce

(Autonomous) Pune-411001

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B. Sc. Programme Objectives and Outcomes

Programme Objectives:

1. To develop conscience towards social responsibility, human values and sustainable development through curriculum delivery and extra-curricular activities
2. To develop scientific temperament with strong fundamental knowledge of the subject
3. To develop analytical thinking and problem-solving skills needed for various entrance and competitive examinations and Post Graduate Studies
4. To train students in laboratory skills and handling equipment along with soft skills needed for placement

Programme Outcomes:

1. The students will graduate with holistic development.
2. The students will be qualified to continue higher studies in their subject.
3. The students will be eligible to appear for various competitive examinations and pursue higher education.
4. The students will be able to apply for the jobs with a minimum requirement of B. Sc. Programme.

Programme Specific Objectives and Outcomes

Programme Specific Objectives:

The B.Sc. Chemistry Programme will enable the students;

PSOB-1. To develop fundamental understanding of Principles of Chemistry as a discipline.
PSOB-2. To understand various laws, concepts, formulae and develop problem solving skills in Chemistry.
PSOB-3. To familiarize with advance level Chemistry and applications required for higher studies.
PSOB-4. To get hands on training on various instruments and develop skills needed in Chemistry lab.

Programme Specific Outcomes:

After successful completion of B.Sc. Chemistry Course student will have:
PSOC-1. Fundamental knowledge of theory and practical courses in Chemistry.
PSOC-2. Understanding of structures, reactivity, mechanism and problem-solving skills.
PSOC-3. Knowledge and confidence to pursue higher studies in Chemistry.

PSOC-4. Skills in laboratory techniques and experience in instrument handling.

Structure of T. Y. B. Sc. Chemistry [NEP]

Sem	Course code	Title of course	No. of Credits and Lectures
V	23SBCH51MM	Physical Chemistry-I	2, 30 Hours
	23SBCH52MM	Inorganic Chemistry-I	2, 30 Hours
	23SBCH53MM	Chemistry Practical-VI	2, 60 Hours
	23SBCH54MM	Chemistry Practical-VII	2, 60 Hours
	23SBCH55MEA	Organic Chemistry-I (Major Elective)	2, 30 Hours
	23SBCH55MEB	Introduction to Medicinal Chemistry (Major Elective)	2, 30 Hours
	23SBCH56MEA	Analytical Chemistry-I (Major Elective)	2, 30 Hours
	23SBCH56MEB	Industrial and Soil Chemistry (Major Elective)	2, 30 Hours
	23SBCH5MVSC	Chemistry Practical-VIII (Vocational Skill Course)	2, 60 Hours
	23SBCH5IKS	Ancient Indian Chemistry (IKS)	2, 30 Hours
VI	23SBCH61MM	Physical Chemistry-II	2, 30 Hours
	23SBCH62MM	Inorganic Chemistry-II	2, 30 Hours
	23SBCH63MM	Organic Chemistry-II	2, 30 Hours
	23SBCH64MM	Chemistry Practical-IX	2, 60 Hours
	23SBCH65MM	Chemistry Practical-X	2, 60 Hours
	23SBCH66MEA	Bioanalytical Chemistry (Major Elective)	2, 30 Hours
	23SBCH66MEB	Chemistry of Biomolecules (Major Elective)	2, 30 Hours
	23SBCH67MEA	Polymer Chemistry (Major Elective)	2, 30 Hours
	23SBCH67MEB	Analytical Chemistry-II (Major Elective)	2, 30 Hours
	23SBCH6OJT	Internship (On-the-Job Training, OJT)	4, 120 Hours

Important points:

1. Each credit is equivalent to 15 lectures of 60 minutes for theory courses and 30 lecture of 60 minutes for practical courses.
2. There will be12 practical sessions per semester of 4 Hours each.
3. Total weeks for teaching and internal evaluation are 15. Out of the 15 weeks, 12 weeks for teaching and 03 weeks for internal evaluation. (Theory as well as Practical).
4. For more details refer to UG rules and regulations (NEP for Science program under Science & Technology) on SPPU website.

Evaluation Pattern (As per NEP Guidelines)

1. Each theory and practical course carry 50 marks equivalent to 2 credits.
2. Each course will be evaluated with Continuous Internal Evaluation (CIE) and End Semester Examination (ESE) mechanism.
3. Continuous internal assessment shall be of 20 marks (40%) while End Semester Examination shall be of 30 marks (60%).

4. To pass each course, a student must secure 40% mark in continuous assessment as well as End Semester Examination i.e., minimum 8 marks in continuous assessment and 12 marks in End Semester Examination in the respective course.
5. For Continuous internal assessment minimum two tests per paper must be organized, of which one must be written test of 10 marks.
6. Method of assessment for internal exams: written test, MCQ type test, Viva-Voce, Project, survey, field visits, tutorials, assignments, group discussion, etc.
7. Theory - End Semester Examination Question Paper Pattern (According to NEP) Note that in theory question paper weightage will be given to each topics equivalent to number of lectures assigned in the syllabus.

Preamble:

The syllabus of Chemistry for third year has been redesigned for NEP-2020 and to be implemented form academic year 2025-26. In NEP pattern semester system has been adopted for B. Sc. degree programme. Different types of courses are introduced at degree level viz. Major, Minor, Skill Enhancement Course (SEC), Vocational Skill Course (VSC), Cocurricular Course (IKS), Course on Indian Knowledge System (IKS), Third year syllabus comprises of 5 Major theory papers, 4 Major Elective Theory Papers, 4 Major Practical course, 1 Vocational Skill Course and 1 compulsory On-the-Job Training Course (OJT).

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SEMESTER-V

Course/ Paper Title	**Physical Chemistry-I**
Course Code	**23SBCH51MM**
Semester	**V**
No. of Credits	**2 (30 Hours)**

Content

Unit No.	Title of Unit	No. of Hours
I	**Photochemistry**	**08**
II	**Investigation of Molecular Structure**	**14**
III	**Quantum Chemistry**	**08**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1	Fundamental laws of photochemistry, Quantum yield, types of photochemical and photo-physical processes.
2	Molar refraction and molecular structure, Dipole moment and molecular structure, electromagnetic spectrum, Rotational spectra of rigid diatomic molecules, Vibrational spectrum of a diatomic molecule, Vibration-rotation spectra, Raman spectra.
3	Fundamentals of de-Broglie hypothesis, Heisenberg's uncertainty principle, Particle in 1-D,2-D, 3-D box, degeneracy, sketching of wave function and probability densities for 1D box.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit I:** After Studying Photochemistry student will able to learn: - 1. The fundamental laws of photochemistry. 2. The concept of quantum yield, to explain the factors affecting on high and low quantum yield and experimental method for its determination. 3. Explain the different types of photochemical processes/reactions. 4. Explain the different types of photo-physical process with the help of Jablonski diagram.

	5. Solve / discuss the problem based applying laws of photochemistry and quantum yield.
2	**Unit II:** After Studying Investigation of Molecular Structure student will able to learn: 1. The term additive and constitutive properties. 2. The term specific volume, molar volume, Specific and molar refraction. 3. The meaning of electrical polarization of molecule, induced and orientation polarization. 4. Dipole moment and its experimental determination by temperature variation method. 5. Electromagnetic spectrum, Nature of wave and its characteristics such as wavelength, wave number, frequency and velocity, Energy level diagram. 6. Classification of molecules on the basis of moment of Inertia. 7. Rotational spectra of rigid diatomic molecules, selection rules, nature of spectral lines and effect of isotopic substitution on rotational spectra. 8. Simple Harmonic oscillator model, Born-Oppenheimer approximation. Vibrational spectra of diatomic molecules selection rules, nature of spectral lines. 9. Need and study of Vibrational-Rotational spectra of diatomic molecule. 10. Explain the difference between Rayleigh, Stokes and anti-Stokes lines in a Raman spectrum. 11. Justify the difference in intensity between Stokes and anti-Stokes lines. 12. Draw the Stokes and anti-Stokes lines in a Raman spectrum. 13. Raman spectra: Concept of polarizability, 14. Pure rotational Raman spectra of diatomic molecules, Energy Expression, Selection rule, Rotational energy level diagram, Rotational Raman spectrum. 15. Solve / discuss the problem based on spectroscopy.
3	**Unit III:** After studying the Quantum Chemistry student will able to learn: - 1. Historical development of quantum mechanics in chemistry. 2. Understand and explain the differences between classical and quantum mechanics. 3. Understand the idea of wave function. 4. de-Broglie hypothesis and the uncertainty principle The concept of operators: Position, momentum and energy. 5. Solving Schrodinger equation for particle in 1D, 2D and 3D model. 6. Physical interpretation of the ψ and ψ^2 and sketching the wave function. 7. Applications to conjugated systems. 8. Solve / discuss the problem based on quantum chemistry.

Syllabus

Unit No.	Title with Contents	No. of Hours
I	**Photochemistry:** Introduction, Difference between thermal and photochemical processes, Laws of photochemistry: i) Grothus - Draper law ii) Stark-Einstein law, Quantum yield, Reasons for high and low quantum yield, Factors affecting high and low quantum yield, Experimental method for the determination of quantum yield, types of photochemical reactions - photosynthesis, photolysis, photocatalysis, photosensitization, Photo-physical Processes - Jablonski diagram depicting various processes occurring in the excited state: Qualitative description of fluorescence and phosphorescence, Chemiluminescence, Numerical Problems. **Ref. No: 1-** Page No. 1154-1178. **Ref. No: 2-** Page No. 1112-1135. **Ref. No: 3-** Page No. 262-281.	**08**
II	**Investigation of Molecular Structure:** **Introduction:** Molar refraction and molecular structure, Dipole moment and molecular structure, electromagnetic spectrum, energy of molecules, Types of molecular spectra. **Microwave Spectroscopy:** Introduction, Classification of molecules on the basis of moment of Inertia, Rotational spectra of rigid diatomic molecules, relative intensities of spectral lines, effect of isotopic substitution on the rotational spectra, Determination of bond length and moment of inertia from rotational spectra, Numerical Problems. **Infrared Spectroscopy:** Introduction, Modes of vibration in polyatomic molecules, Simple Harmonic oscillator, force constant, Vibrational spectrum of a diatomic molecule assuming harmonic oscillator: Vibrational Energy expression, Selection rule, zero-point energy, Vibrational energy level diagram with transitions, spectrum depiction, **Vibration-rotation Spectra:** Born-Oppenheimer approximation, Energy expression for vibrational rotor, Selection rules, Vibrational-rotational energy level diagram with transitions, Nature of vibrational spectra, P, Q and R branches of lines of the IR spectra, Numerical Problems. **Raman Spectroscopy:** Introduction, Classical and Quantum theory of Raman effect, Rayleigh, Stokes and anti-stokes lines, Pure rotational Raman spectra of linear diatomic molecules. **Ref. No: 3-** Page No. 413-455. **Ref. No: 4-** Page No. 33-59, 60-75, 111-119.	**14**
III	**Quantum Chemistry:** Introduction, de-Broglie hypothesis, The Heisenberg's uncertainty principle, quantisation of energy, Operators, Schrodinger wave equation, well behaved function, Particle in a one-, two and three-dimensional box (no derivation), Physical interpretation of the ψ	**08**

	and ψ^2, sketching of wave function and probability densities for 1D box, degeneracy, applications to conjugated systems, Numerical Problems. **Ref. No: 1-** Page No. 50-58**.** **Ref. No: 2-** Page No. 21-110**.**	

Reference Books:

1. Essentials of Physical chemistry by Bahl and Tuli-Revised Multicolour Edition 2009, S. Chand and Company Ltd.
2. Principles of physical chemistry by B.R. Puri, L.R. Sharma, M.S. Pathania
3. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000.
4. Fundamentals of molecular spectroscopy by C.N. Banwell and E. M. McCash.

Additional References:

1. Physical Chemistry by Thomas Engel, Philip Reid, Warren Hehre.
2. Physical Chemistry by G. M. Barrow, International student Edition,Mc Graw Hill.
3. University General Chemistry by C.N.R. Rao, Macmillan.
4. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
5. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
6. Principles of Physical Chemistry by S. H. Maron, C. H. Prutton, 4th Edition.
7. Quantum Chemistry by Donald A McQuarrie, Viva Student Edition

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SEMESTER-V

Course/ Paper Title	**Inorganic Chemistry-I**
Course Code	**23SBCH52MM**
Semester	**V**
No. of Credits	**02 (30 Hours)**

Unit No.	Title of Unit	No. of hours
I	**Molecular Orbital Theory of Coordination Compounds**	**08**
II	**Acid–Base and Donor–Acceptor Chemistry**	**08**
III	**Chemistry of Transition Elements**	**04**
IV	**Chemistry of f-block Elements**	**06**
V	**Introduction to Bioinorganic Chemistry**	**04**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1	Understanding of all the basic concepts molecular orbital theory and MO energy level diagrams of octahedral complexes with sigma bonding and Without pi-bonding
2	Student will learn the concept of acid base and their theories and they will also come to know different properties of acids and bases.
3	To know trends in periodic properties of these elements w.r.t. size of atom and ions, reactivity, catalytic activity, oxidation state, complex formation ability, color, magnetic properties, non-stoichiometry, density, melting point, boiling point
4	The ability to write electronic configuration of lanthanides and actinides and oxidation states of lanthanides and actinides and common oxidation states.
5	To understand the role of metals in biological systems, role of inorganic ions & compounds. To know about the metalloproteins such as haemoglobin, myoglobin, and Vit. B12.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit I:** 1. Explain electro-neutrality principle and different types of pi bonding. 2. Able to explain Nephelauxetic effect towards covalent bonding. 3. Explain MOT of Octahedral complexes with sigma bonding. 4. Able to explain Charge Transfer Spectra. 5. Able to compare the different approaches to bonding in Coordination compounds.
2	**Unit II:** 1. Student will learn the concept of acid base and their theories. 2. They will also come to know different properties of acids and bases. 3. Strength of various types acids. 4. How acid and base strengths get affected in non-aqueous solvents.
3	**Unit III:** 1. To know position of d-block elements in periodic table. 2. To know electronic configuration of elements. 3. To know trends in periodic properties of these elements w.r.t. size of atom and ions, reactivity, catalytic activity, oxidation state, complex formation ability, color, magnetic properties, non-stoichiometry, density, melting point, boiling point.
4	**Unit IV:** 1. The meaning of term f-block elements, Inner transition elements, lanthanides, actinides. 2. Electronic configuration of lanthanides and actinides. 3. Oxidation states of lanthanides and actinides and common. 4. Separation lanthanides by modern methods. 5. Lanthanide contraction and effects of lanthanide contraction on post-lanthanides. 6. Use of lanthanide elements in different industries. 7. Transuranic elements. 8. Preparation methods of transuranic elements. 9. Nuclear fuels and their applications. 10. Why transuranic elements are called as the synthetic elements? 11. IUPAC nomenclature for super heavy elements with atomic no. 100 onwards.
5	**Unit V:** 1. Identify the biological role of inorganic ions & compounds. 2. Know the abundance of elements in living system and earth crust. 3. Give the classification of metals as enzymatic and non-enzymatic. 4. Understand the role of metals in non-enzymatic processes. 5. Know the metalloproteins of iron. 6. Explain the functions of haemoglobin and myoglobin in O2 transport and storage. 7. Understand the toxicity of CN- and CO binding to Hb. 8. Draw the structure of Vit.B12 and give its metabolism.

Syllabus

Unit No.	Title With Content	No. of Lectures
I	**Molecular Orbital Theory of Coordination Compounds:** Electro-neutrality principle, multiple bonding (dπ-pπ and dπ-dπ), Nephelauxetic effect and Nephelauxetic series (Recapitulation from VBT and CFT), Need and introduction of MOT, Assumptions, MO treatment to octahedral complexes with sigma bonding, Formation of MO's from metal orbitals and Composite Ligand Orbitals (CLO), MO correlation diagram for octahedral complexes with sigma bonding, effect of π bonding on MO correlation diagram, Charge transfer spectra, Advantages of MOT over VBT and CFT. **Ref:1** (pp226-231)**, 2** (pp 95-120)**.**	**08**
II	**Acid–Base and Donor–Acceptor Chemistry:** Concepts of Acids–Bases, Arrhenius Concept, Brønsted–Lowry Concept, Solvent System Concept, Lewis Concept, Hard and Soft acids and bases, Acid–Base Reactions, Strengths of Acid and Base (proton affinity, acidity and basicity of binary hydrogen compounds, inductive effects, steric effect, strength of oxy acids, acidity of cations in aqueous solutions, non-aqueous solvents, super acids). **Ref:6:** (67- 178, 183 – 208)	**08**
III	**Chemistry of Transition elements:** Position in periodic table, electronic configuration, trends in properties w.r.t.(a) size of atoms and ions (b) reactivity (c) catalytic activity (d) oxidation state (e) complex formation ability (f) colour (g) magnetic properties (h) non-stoichiometry (i) density, melting & boiling points. **Ref:4**	**04**
IV	**Chemistry of f-block elements:** Introduction of f-block elements- on the basis of electronic configurations, occurrence and reactivity, F-block elements as Lanthanide and Actinide series. **I. Lanthanides:** Position in periodic table, Name and electronic configuration of lanthanides, Oxidation States, atomic and ionic radii, Lanthanide contraction, its causes and consequences on chemistry of Lanthanides and post lanthanide elements, Occurrence and separation: Bulk separation, Individual separation by modern methods viz., Ion exchange and solvent extraction method, applications of lanthanides. **II. Actinides:** Position in periodic table, names and their electronic configurations. IUPAC nomenclature system for super heavy elements, Oxidation States, Occurrence and general methods of preparation of transuranic elements viz., Neutron Bombardment, Accelerated projectile bombardment and Heavy ion bombardment. Nuclear Fuels-Nuclear fission and fusion fuels, comparison between Lanthanides and Actinides. **Ref:5** (874 – 875, 879-886, 891-893, 898-900)	**06**
V	**Introduction to Bioinorganic Chemistry:** Definition and Scope of Bioinorganic Chemistry, Importance of metals in biological systems, Distinction between bioinorganic and organic biochemistry, Brief history and development of bioinorganic chemistry, Role of essential elements (e.g., Fe, Cu, Zn, Mg, Ca), Biological significance of trace elements (e.g., Co, Mn, Mo, Se), Distribution of metals in the human body, Disorders caused by deficiencies or excess of metals. **Ref. 5(353, 775, 779, 796-797)**	**04**

Reference Books:

1. Concise Inorganic Chemistry by J.D. Lee - 4th Edition pp226-231
2. Physical Inorganic Chemistry A Coordination Chemistry Approach S. F. A. Kettle Springer-Verlag Berlin Heidelberg GmbH, 1996 pp 95-120
3. Theoretical Inorganic Chemistry by Day and Selvin (Relevant Pages)
4. Concise Inorganic Chemistry by J.D. Lee - 5th edition
5. Concise Inorganic Chemistry by J.D. Lee - 5th Edn. 874 – 875, 879-886, 891-893, 898-900.
6. Inorganic chemistry, Gary L Messler and Donald A Tar, Third Ed, Pearson publisher, pages: 67- 178, 183 – 208.
7. Fundamental Chemistry by A. K. De (3rd Ed.)
8. Environmental chemistry by A.K.De Publisher- Wiley Eastern Limited New Age International Limited Page No. 75-100.

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SEMESTER-V

Course/ Paper Title	**Chemistry Practical-VI**
Course Code	**23SBCH53MM**
Semester	**V**
No. of Credits	**2 (60 Hours)**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1	Experimental aspect of photo-fluorometer for the quantitative trace analysis
2	Refraction phenomena through the specific experiment
3	Quantitative estimations of metal ions by Spectro-photometric method
4	Applications of conductometric for qualitative and quantitative analysis
5	Investigation of molecular structure by spectral analysis

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	To estimate the concentrations of Riboflavin, Quinine and Aluminium
2	To investigate the specific and molar refractions, percent composition and molar refraction is an additive property.
3	To estimate the concentrations of metal ions by understanding the principle of spectrophotometer/colorimeter.
4	To understand the principle and applications of conductometry technique for the qualitative and quantitative estimations.
5.	Analysis of experimental vibrational-rotational and pure rotational Raman spectra of diatomic molecules

Syllabus

Sr. No.	Title with Contents	Practical Sessions
	Section A: Photoflurometry: (Any Three)	
1.	To determine the concentration of Riboflavin from vitamin supplementary capsules / syrup / tablet sample by Photoflurometry (working curve method).	1

2.	To determine the concentration of Quinine from given sample by Photoflurometry (Standard addition method).	1
3.	To determine the concentration of Quinine from given sample by working curve method and its confirmation by standard addition method.	1
4.	To determine the concentration of Aluminium in given sample by photoflurometry.	1
	Section B: Refractometry (Any Two)	
5.	To determine the molecular refractivity of the given liquids A, B, C and D.	1
6.	To determine the molar refraction of homologues methyl, ethyl and propyl alcohol and show the constancy contribution to the molar refraction by $-CH_2$ group	1
7.	To determine the specific refractivity's of the given liquids A and B and their mixture and hence determine the percentage composition their mixture C	1
	Section C: Spectrophotometry and Colorimetry (Any Three)	
8.	To determine the concentration of Cu^{2+} ions in given solution with EDTA photometrically.	1
9.	To determine the concentration of Fe^{3+} ions in given solution by thiocyanate method photometrically.	1
10.	To determine the concentration of cobalt by using R-nitroso salt method photometrically.	1
11.	To determine the indicator constant of methyl red indicator.	1
12.	To determine the order of reaction for the oxidation of alcohol by potassium dichromate in acidic medium colorimetrically	1
13.	To determine the concentration of Co^{2+} and Ni^{2+} ions by Simultaneous method spectrophotometrically.	1
	Section D: Conductometry (Any Three)	
14.	Titration of a mixture of weak acid and strong acid with strong alkali.	1
15.	To determine the velocity constant of hydrolysis of ethyl acetate by NaOH solution by conductometric method.	1
16.	To determine equivalent conductance at infinite dilution ($\lambda\infty$) of strong electrolyte (NaCl or KCl) and to verify Onsager equation	1
17.	To estimate the amount of lead present in given solution of lead nitrate by conductometric titration with sodium sulphate	1
18.	To determine the relative strength of monochloro acetic acid and acetic acid conductometrically	1
	Section E: Table Work (Any One)	
19.	Analysis of the given vibration-rotation spectrum of HCl(g)	1
20.	Analysis of the given pure rotational Raman spectrum of diatomic molecule	1

References:

1. Practical physical chemistry, A. Findlay, T.A. Kitchner (Longmans, Green and Co.)
2. Systematic experimental physical chemistry, S. W. Rajbhoj, T. K. Chondekar, Anjali publication.
3. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Garg (R. Chand and Co., Delhi.)
4. Advanced Practical Chemistry, Jagdamba Sing et al, Pragati Prakashan, Merrut.
5. Experimental Physical Chemistry by D. P. Shoemaker, Mc. Growhill, 7th Edition, 2003.
6. Physical chemistry by Wien (2001)
7. Advance Physical Chemistry Experiment, Gurtu and Gurtu, Pragati Publication (Meerut),
8. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
9. Practical physical Chemistry, B. Vishwanathan and P. S. Raghwan, Viva Books
10. Experimental Physical Chemistry, Halpern, A. M. & McBane, G. C. 3rd Ed.; W.H. Freeman & Co.: New York (2003).
11. T. Y. B. Sc. Practical Chemistry (2019 Pattern), Manali Prakashan

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SEMESTER-V

Course/ Paper Title	**Chemistry Practical-VII**
Course Code	**23SBCH54MM**
Semester	**V**
No. of Credits	**02 (60 Hours)**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1.	To learn about gravimetric estimations and significance in quantitative analysis
2.	To carry out synthesis and analysis of synthesized coordination complexes
3.	To carry out synthesis of nanoparticles and to characterize nanoparticles using spectrophotometry.
4.	To know about the principles of Thermo-Gravimetric Analysis (TGA).

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1.	To understand the principles of Gravimetric analysis
2.	Student should be able to understand principles of Synthesis and purity of coordination complexes
3.	To study principles of solubility and solubility product and thus to understand the principle involved in Qualitative analysis.
4.	Should be able to analyse, conclude and solve problems based on principles of Thermo-Gravimetric Analysis (TGA).

Syllabus:

Sr. No.	Title with Contents	Practical Sessions
	A. Gravimetric Estimations (Any Five)	
1	Gravimetric estimation of Ba as BaSO4 using homogeneous precipitation method	1
2	Gravimetric estimation of Nickel as Ni-DMG	1
3	Gravimetric estimation of Al as Aluminium oxide	1
4	Gravimetric estimation of Fe as Fe2O3	1
5	Analysis of Food/Pharmaceutical sample for ash and sulphated ash example-Aspirin,	1
6	Analysis of sodium bicarbonate from mixture by thermal decomposition method	1
7	Determination of water of crystallization by thermal decomposition	1
	B. Inorganic preparations (Any Five)	
1	Synthesis and purity of Potassium Trioxalatoferrate (III), K3[Fe(C2O4)3]	1
2	Synthesis and purity of Manganese (III) acetylacetonate [Mn(acac)3].	1
3	Synthesis of ZnO nanoparticles.	1
4	Synthesis and purity of hexamminenickel (II) chloride	1
5	Synthesis and purity of Potassium dioxalatocuprate (II)	1
6	Preparation of tris(glycinato)nickelate(II), [Ni(gly)3]	1
7	Synthesis of Silver nanoparticles and to find the band gape spectrophotometrically	1
	C. Inorganic Qualitative Analysis (Any Two)	
1	Qualitative and confirmatory tests of inorganic toxicants of any four ions (Borate, copper, hypochlorite or nitrate or nitrite, Sb or Bi, Iodate, H2O2)	1
2	Inorganic Qualitative analysis (5 mixtures) [1 simple water soluble mixture, 2 mixtures containing borates and 2 mixtures containing phosphates]	1
3	Limit test for iron, chloride and sulphate from pharmaceutical raw materials.	1
4	To study the principles of solubility and solubility product and thus to confirm the principle involved in Inorganic Qualitative analysis	1

References:

1. Vogel's textbook of Inorganic Quantitative Analysis, Jeffery, Basset, Mendham Deney, 5th Ed, Longman Scientific Technical, USA (co-published with John Wiley Sons)
2. Indian Pharmacopeia, Vol-2; 2007
3. Basics of Analytical toxicology, World Health Organization
4. Green Chem-https://fdocuments.in/document/green-chem.html
5. https://www.studocu.com/ec/document/universidad-de-investigacion-de-tecnologia-experimental-yachay/fisica-matematica/otros/the-gravimetric-analysis-of-barium- chloride-hydrate/8364963/view
6. https://effectiveness.lahc.edu/academic_affairs/sfcs/chemistry/Shared%20Documents/ Decomposing%20Baking%20Soda.pdf
7. Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horword Publishing, Chichester) 1999.
8. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
9. Journal of chemical education: Synthesis of cis-Cu(gly)2 Trans-Cu(gly)2 and cis-ni(gly).2H_2O and their characterization using thermal and spectroscopic technique – a Capstone laboratory experiment.
10. Nanotechnology: Principles and Practices by Dr. Sulbha Kulkarni. Third Edition, Springer

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SEMESTER-V

Course/ Paper Title	**Organic Chemistry-I (Major Elective)**
Course Code	**23SBCH55MEA**
Semester	**V**
No. of Credits	**2 (30 Hours)**

Content

Unit No.	Title of chapter	No. of lecture
I	**Active Methylene Compounds**	**6**
II	**Rearrangement Reactions**	**9**
III	**Elimination Reactions**	**9**
IV	**Retrosynthetic Analysis and Applications**	**6**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1	To develop the understanding of nuances of designing organic synthesis and associated concepts.
2	To develop understanding of reactions of carbanion, named reactions, kinetics of elimination reactions with mechanism
3	To develop problem solving skills, mechanisms and predict the product.
4	To learn the simplification of synthesizing larger molecules through retro-analysis.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit I: Active Methylene Compounds:** Students should be able to understand Meaning of active methylene group, Reactivity of methylene group, Synthetic applications ethyl acetoacetate (EAA) and malonic ester (DEM), to predict product and design molecules from EAA and DEM
2	**Unit II: Molecular Rearrangements** Students will study

	Rearrangement reaction, Different types of intermediate in rearrangement reactions, To write the mechanism of some named rearrangement reactions and their applications, Electrocyclic rearrangement with their mechanisms.
3	**Unit III: Elimination Reactions** Students will study 1,1 and 1,2 elimination, E1, E2 and E1cB mechanism with evidences of these reactions, Understand stereochemistry by using models and learn reactivity of geometrical isomers, Orientation and reactivity in E1 and E2 elimination, Hoffmann and Saytzeff's Orientation, Effect of factors on the rate elimination reactions
4	**Unit IV Retrosynthetic Analysis and Applications** Students will be able to suggest complete synthesis of target molecules through application of disconnection approach and utilize various synthetic strategies needed in problem solving.

Syllabus

Unit No.	Title with Contents	No. of Lectures
I	**Active Methylene Compounds** Definition, Preparation of Ethylacetoacetate and Synthetic uses of ethylacetoacetate, Preparation of Diethyl malonate and Synthetic uses of diethyl malonate, (preparation of non-heteromolecules having upto 6 carbon). **Ref. 1:** Pages 864 – 875 **Ref. 2:** Pages 859 – 874 **Ref. 4:** Pages 206 – 213	**06**
II	**Rearrangement Reactions** Introduction, Types of rearrangement, Types of reactive intermediate involved in different rearrangements, Rearrangement – Beckmann, Baeyer-Villiger, Favorskii, Curtius, Lossen, Schmidt and Pinacol-Pinacolone with mechanism. Claisen and Cope rearrangements with mechanism. **Ref. 3:** Pages 618-656. **Ref. 5:** Pages 89-94, 105-107, 112-114, 122-125, 158-161 **Ref. 6:** Pages 130-132	**09**
III	**Elimination Reactions** Introduction; Types of eliminations-1,1; 1,2 elimination, Mechanism with evidences of E1and E2, E1cB reactions, stereochemistry of E1 and	**09**

	E2 elimination, Orientations and reactivity in E1 and E2 elimination-Hoffmann and Saytzeff's Orientation, Factors affecting the reactivity-effect of structure, attacking base and leaving groups. **Ref. 1:** Pages 305-326 **Ref. 2:** Pages 260-265 **Ref. 3:** Pages 472-496 **Ref. 4:** Pages 188-194	
IV	**Retrosynthetic Analysis and Applications** Introduction, Different terms used – Disconnection, Synthons, Synthetic equivalence, FGI, TM. One group disconnection, Retrosynthesis and Synthesis of target molecules: Acetophenone, Crotonaldehyde, Cyclohexene, Benzyl benzoate, and Benzyl diethyl malonate **Ref 7 Page No.: 1-34** **Ref 8 Page No.: 694-722**	**06**

Reference Books:

1. R.T. Morrison & R.N. Boyd: Organic Chemistry, 7th edition, Prentice Hall.
2. Organic Chemistry: Graham Solomans
3. E. S. Gould: Mechanism and Structure in Organic Chemistry
4. I.L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S.
5. S. N. Sanyal: Reactions, Rearrangements and Reagents
6. Jagdamba Singh, Jaya Singh: Photochemistry and Pericyclic reactions.3rd edition
7. Designing Organic Synthesis by Stuart Warren 1983.
8. Organic Chemistry by Clayden, Greeves, Warren and Wothers. Second edition

Additional References:

1. Organic Chemistry: Clayden, Greeves, Wothers, Warren, Oxford Press.
2. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman

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Semester V

Course/ Paper Title	**Introduction to Medicinal Chemistry (Major Elective)**
Course Code	**23SBCH55MEB**
Semester	**V**
No. of Credits	**2 (30 Hours)**

Content

Unit No.	Title of Unit	No. of Hours
I	**An Introduction to Drugs, their Action and Immunobiologicals**	**07**
II	**Bio-physicochemical Properties in Drug Action and Design**	**07**
III	**Drugs for Infectious Diseases**	**08**
IV	**Drugs for Non-infectious diseases**	**07**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1.	This course has been introduced at undergraduate level to provide an overview of Medicinal Chemistry branch, which is an independent and applied branch of Chemistry addressing Drug Design and Discovery.
2.	The course will help in the fundamental understanding of concepts of Drugs, Diseases, applications, design and discovery.
3.	Infectious and Non-Infectious diseases and their drugs are also discussed to provide a broad perspective to the students.
4.	The course shall help to motivate students to pursue the field as a career

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	Upon completion of the course the student shall be able to understand, The basics of medicinal chemistry, biophysical properties, overview of basic concepts of traditional systems of medicine.
2	Over view of the overall process of drug discovery, and the role played by medicinal chemistry in this process.
3	Biological activity parameters and importance of stereochemistry of drugs and receptors.
4	Knowledge of mechanism of action of drugs belonging to the classes of infectious and non-infectious diseases. application of natural and synthetic drugs

Syllabus

Unit No.	Title with Contents	No. of Lectures
I	**An Introduction to Drugs, their Action and Immunobiologicals** **A.** Introduction, need of new drugs, Historical background of drug discovery and design, Sources of drugs, Classification of drugs, Introduction to drug action **B.** Immunobiologicals: Vaccines: Introduction, Methods of vaccine production: Inactivated pathogens, Live/Attenuated Pathogens and Cellular Antigen from a pathogen, SARS-CoV-19 **Ref. 1: Pages 37-53** **Ref. 2: Pages 4-11,** **Ref. 4: Pages 4-9** **Ref. 3: Pages 165-168,** **Ref. 9: Online** **Ref.10: Online**	**07**
II	**Bio-physicochemical Properties in Drug Action and Design** Introduction, Acidity/Basicity, Solubility, Ionization, Hydrophobic and hydrophilic properties, Lipinski Rule, Terminology in Medicinal Chemistry: Pharmacology, Pharmacophore, Pharmacodynamics, Pharmacokinetics, metabolites, antimetabolites and therapeutic index. Importance of stereochemistry in drug action (Example: Ibuprofen), Concept of rational drug design: Structure activity relationship, Drug receptor understanding **Ref. 1: Pages 57-75, 95-96** **Ref. 2: Pages 189-274, 384-392,** **Ref. 4: Pages 29-61**	**07**
III	**Drugs for Infectious Diseases** Introduction, Structures, Mode of Action and Applications: A. Antimicrobial Agents: Classification on i) Type of action: Bacteriostatic and Bactericidal ii) Source (Natural, Synthetic and Semisynthetic) iii) Spectrum of activity: Narrow and Broad Spectrum iv) Chemical structure: β-lactams (Penicillin), Macrolides (Azithromycin), Sulphonamides (Sulfadiazine), and Tetracyclins (Chlortetracycline) B. Anti-fungal and anti-viral agents: Example: Amphotericin-B, Acyclovir **Ref. 1: Pages 131-157,** **Ref. 2: Pages 413-472,** **Ref. 3: Pages 258-308,** **Ref. 4: Pages 191-228** **Ref. 6: Online** **Ref. 7: Online**	**09**
IV	**Drugs for Non-infectious diseases** Introduction, Structures, Mode of Action, and Applications: A. i) Anti-inflammatory and Analgesic Agents: Example: Aspirin, Paracetamol, and Ibuprofen, ii) Psychoactive Agents: Sedatives and Hypnotics: Example: Benzodiazepines, B. Metallodrugs as Chemotherapeutic Agents: Examples: Aluminium based antacids, Salvarsan, Cis Platin, and Transition Metal Complexes **Ref. 3: Pages 443-457, 509-515,637-647, 776-792** **Ref. 5: Pages 69-70,481-491**	**07**

References:

1. Fundamentals of Medicinal Chemistry by Gareth Thomas, University of Portsmouth, UK.
2. An Introduction to Medicinal Chemistry, Patrick, G. Oxford. University Press (Vth Edition).
3. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical, Charles Owens Wilson, John H. Block, Ole Gisvold, John Marlowe Beale.
4. Foye's Principles of Medicinal Chemistry by David A. Williams, Thomas L. Lemke, William O. Foye (VIIth Edition), Kluwer publication.
5. Metallo-therapeutic Drugs and Metal-Based Diagnostic Agents by Marcel Gielen and Edward R.T. Tiekink
6. Research and Development on Therapeutic Agents and Vaccines for COVID-19 and Related Human Coronavirus Diseases, Cynthia Liu et al., ACS Cent. Sci. 2020, (6),315−331, http://dx.doi.org/10.1021/acscentsci.0c00272
7. A comprehensive overview of vaccines developed for pandemic viral pathogens over the past two decades including those in clinical trials for the current novel SARSCoV-2, Kannan Damodharan et al., RSC Adv., 2021, 11, 20006–20035, http://dx.doi.org/10.1039/d0ra09668g

Additional References

1. Medicinal chemistry, fourth edition, Ashutosh Kar (2007).
2. Metallodrugs in Medicinal Inorganic Chemistry Katja Dralle Mjos and Chris Orvig, Chem. Rev. 2014, 114, 4540-4563, http://dx.doi.org/10.1021/cr400460s
3. Metallodrugs are unique: opportunities and challenges of discovery and development, E. J. Anthony et.al. Chem. Sci., 2020, 11, 12888, http://dx.doi.org/10.1039/d0sc04082g.

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SEMESTER V

Course/ Paper Title	**Analytical Chemistry-I (Major Elective)**
Course Code	**23SBCH56MEA**
Semester	**V**
No. of Credits	**2 (30 Hours)**

Content

Unit No.	Title of Unit	No. of lecture
I	**Gravimetry**	**08**
II	**Thermal methods of Analysis**	**06**
III	**Nephelometry and Turbidimetry**	**05**
IV	**Parameters of Instrumental Analysis**	**03**
V	**UV-Visible Spectroscopy**	**08**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1	To determine the quantity of analyte based on mass of a solid.
2	To identify important parameters in analytical processes or estimations.
3	To study instrumental technique for analysis of sample.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit I:** After Studying gravimetry student will be able to learn: 1. Define/ Explain basic terms in gravimetry, qualitative analysis and parameters in instrumental analysis. Such as Gravimetry, precipitation, precipitating agent, washing of ppt. drying and ignition of ppt., 2. Explain different principles involved in the gravimetry 3. Learning reagent for analysis, reaction condition to convert analyte into measurable form, drying and ignition temperature for ppt in gravimetry. 4. Perform quantitative calculations depending upon equations which student has studied in the theory. 5. Solve / discuss the problem based on solubility product.
2	**Unit II:** After Studying thermogravimetry chemistry, student will be able to learn: - 1. Define / explain term thermal method of analysis, classification of thermal

	method of analysis. 2. Explain different principles involved in the TGA and DTA 3. Discuss factors affecting TGA and DTA 4. Solve /discuss the problem based on TGA
3	**Unit III:** After studying Nephelometry and Turbidometry the student will be able to learn: 1. Explain / define different terms in Nephelometry and Turbidometry. etc. 2. Explain difference in Nephelometry and Turbidometry. 3. Discuss factors affecting Nephelometry and Turbidometry. 4. Solve / discuss the problem based on Nephelometry and Turbidometry.
4.	**Unit IV:** After studying Parameters of instrumental analysis, the student will be able to learn. 1. Define/Explain Linearity range, detection limit, precision, accuracy, Sensitivity, Selectivity, Robustness and Ruggedness 2. Identify important parameters in analytical processes or estimations. Example: minimum analyte concentration in particular method, reagent concentration in particular analysis.
5.	**Unit V:** After studying UV visible Spectroscopy the student will able to learn:- 1. Define/Explain electromagnetic radiations, spectrophotometry, Beers law, absorbance, transmittance, molar absorptivity, monochromator, wavelength of maximum absorbance. 2. To explain the working of Colorimeter and Spectrophotometer. 3. Application of single beam colorimeter, single and double beam Spectrophotometer 4. Solve / discuss the problem based on Spectrophotometry.

Syllabus

Unit No.	Title with Contents	No. of Lectures
I	**Gravimetry:** Introduction to gravimetric analysis; Precipitation methods; The colloidal state; Supersaturation and precipitate formation; The purity of the precipitate: Co-precipitation; ; Conditions of precipitation; Precipitation from homogeneous solution; Washing the precipitate; Ignition of the precipitate: quantitative separations based upon precipitation methods: Fractional precipitation; Organic precipitants (8- hydroxyquinoline, DMG), Gravimetric Calculations. Applications of Gravimetry: Determination of Al (III) by 8-hydroxyquoline, Determination of phosphate as ammonium molybdophosphate, Numerical **Ref. 1:** Page No. 417-428, 433-444, 446, 451, 464, 48 **Ref. 2:** Page No. 342 - 362	**08**
II	**Thermal methods of Analysis:** General discussion, Thermogravimetry, Experimental factors affecting TG analysis, Instruments for thermogravimetry, Applications: Thermogravimetric analysis o f $CaC_2O_4.H_2O$, $CuSO_4.5H_2O$, Differential Thermal Analysis: Introduction, instrumentation for DTA and DSC, experimental and instrumental factors, applications: DTA of	**06**

	copper sulphate pentahydrate, Purity of Pharmaceutical by DSC **Ref. 1-** Page No. 428-433 **Ref. 2-** Page No. 503-522 **Ref. 4-** Page No. 884-890	
III	**Nephelometry and Turbidimetry:** Introduction, Principles and instrumentation of Nephelometric and Turbidimetric analysis, Difference between Nephelometric and Turbidimetric measurements, Choice between Nephelometry and Turbidimetry, Factors affecting Nephelometric and Turbidimetric measurements, Quantitative Applications, Numerical Problems **Ref. 5-** Page No. 781-785 **Ref. 6-** Page No. 380-390	**05**
IV	**Parameters of Instrumental Analysis:** Techniques, Methods, Procedures, and Protocols, Selecting an Analytical Method, Accuracy, Precision, Sensitivity, Selectivity, Robustness and Ruggedness, Scale of Operation, equipment, Time, and Cost, Making the Final Choice, Developing the Procedure, Calibration and Standardization, Sampling, Validation, Protocols. **Ref. 5-** Page No. 35-48	**03**
V	**UV Visible Spectroscopy:** Introduction, Theory of spectrophotometry and colorimetry-Beer's law, Application of Beer's Law, Spectrophotometry: Wavelength selection by prism and diffraction grating, Radiation source, cells, data presentation, single-beam spectrophotometer, Double-beam spectrophotometers, Choice solvent, general procedure for colorimetric estimation. Applications: spectrophotometric titration (example Cu (II) with EDTA), Determination of pKa value of indicator Numerical **Ref. 1-** Page No. 645-725 **Ref. 2-** Page No. 658-717	**08**

Reference Books:

1. Vogel's textbook of Inorganic Quantitative Analysis, Jeffery, Basset, Mendham Deney, 5th Ed, Longman Scientific Technical, USA (co-published with John Wiley Sons)
2. Vogel's textbook of Inorganic Quantitative Analysis, Mendham, Deney Barnes, 6th Ed, Pearson education
3. Analytical Chemistry by G. D. Christian, et al , Wiley, 6th Ed.
4. Principles of Instrumental Analysis: Holler, Skoog, Crouch 6th Ed. Thomson Publication
5. Modern Analytical Chemistry, David Harvey, Mc-Graw Hill Higher education
6. Vogel's Qualitative Inorganic Analysis, G. Svehla, Pearson, 7th Ed.
7. Textbook of Quantitative Chemical Analysis- 3rd Edition, A. I. Vogel
8. Instrumental Methods of Chemical Analysis- Chatwal and Anand

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SEMESTER-V

Course/ Paper Title	**Industrial and Soil Chemistry (Major Elective)**
Course Code	**23SBCH56MEB**
Semester	**V**
No. of Credits	**2 (30 Hours)**

Content

Unit No.	Title of Unit	No. of Hours
I	**Modern Approach to Chemical Industry**	**02**
II	**Manufacture of Basic Chemicals**	**04**
III	**Agrochemicals**	**06**
IV	**Petrochemicals and Eco-friendly fuels**	**06**
V	**Cement and Glass Industry**	**06**
VI	**Sugar and Fermentation**	**06**

Aims & Objectives of the Course: The student should

Sr. No.	Objectives
1.	Understand the structure, operations, and key processes of chemical industries.
2.	Learn the manufacturing principles of ammonia, nitric acid, and sulfuric acid.
3.	Explore agrochemicals, their synthesis, and environmental impact.
4.	Study petrochemicals, eco-friendly fuels, and renewable energy sources.
5.	Examine processes in food, cement, glass, sugar, and fermentation industries.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1.	Outline basic operations and safety measures in chemical industries.
2.	Explain the production processes of ammonia, nitric acid, and sulfuric acid.
3.	Classify and evaluate agrochemicals and biopesticides.
4.	Summarize petroleum refining and eco-friendly fuel applications.
5.	Describe food preservation, cement, glass production, and fermentation processes.

Syllabus

Unit No	Title with Contents	No. of Lectures
I	**Modern Approach to Chemical Industry** Introduction, basic requirements of chemical industries, chemical production, unit process and unit operations, Quality control and quality assurance, process control, research and development, human resource, safety measures, classification of chemical reactions, batch and continuous process, Conversion, selectivity and yield, copy-right act, patent act, trademarks. **Ref. 1 Chapter 2 (relevant pages), Ref. 2, Ref.3, Ref. 4 Page 55-72**	**02**
II	**Manufacture of Basic Chemicals** **Ammonia**: Physicochemical principles, Manufacture of ammonia by Modified Haber-Bosch process and its uses. **Nitric acid:** Physicochemical principles, Manufacture of nitric acid by Ostwald's process, involved and its uses. **Sulphuric acid:** Physicochemical principles, Manufacture of sulphuric acid by contact process and its uses. **Ref. 1 Page 571-588, 618-664**	**04**
III	**Agrochemicals** General introduction and scope of agrichemicals, meaning and examples of Insecticides, Herbicides, Fungicides, Rodenticides, Pesticides, plant growth regulators. Pesticide formulation, slow-release pesticide formulations, storage stability test and industrial entomology. Advantages and disadvantages of agrochemicals, structure DDT. BHC, Warfarin, Aldrin, Endosulphan. Synthesis and applications DDT, BHC and Edosulphan. Biopesticides like Neem oil and karanj oil. **Ref. 5, 6 and 7.**	**06**
IV	**Petrochemicals and Eco-friendly fuels** **Petrochemicals:** Introduction, occurrence, composition of petroleum, resources, processing of petroleum, calorific value of fuel, cracking, octane rating (octane number), cetane number, flash point and petroleum refineries, petrochemicals applications, synthetic petroleum, lubricating oils and additives. **Fuel and Eco-friendly fuels:** liquid, gaseous (LPG, CNG) fossils, diesel, bio-diesel, gasoline, aviation fuels, Use of solar energy for power generation. **Ref. 11, 12, 13**	**06**

V	**Cement and Glass Industry** **Cement Industry:** Introduction, importance, composition of Portland cement, materials, proportioning of raw materials, setting and hardening of cement, reinforced concrete. **Glass Industry:** Introduction, importance, physical and chemical properties of chemical reaction, annealing of glass special glasses: coloured safety hard, borosil optical, photosensitive, conducting, glass luminates. **Ref. 1 Page 313-333** **Ref. 8 Page 713-176** **Ref. 10 Page 188-192**	**06**
VI	**Sugar and Fermentation Industry** a) Sugar industry: Introduction, manufacture of cane sugar, extraction of juice, purification of juice, sulfitation and carbonation, evaporation, crystallization, separations of crystals, drying refining, grades, recovery of sugar from molasses, by-product of sugar industry **b) Fermentation Industry:** Introduction, importance, conditions favourable for fermentation, Characteristics of enzymes, short account of some fermentation processes, Alcohol beverages, Manufacture of beer, manufacture of sprit, manufacture of wines, manufacture of vinegar, manufacture of power alcohol, ethyl alcohol from molasses. **Ref. 1 Page 160-171** **Ref. 8 Page 247-265** **Ref. 9 Page 197-212.**	**06**

References:

1. Industrial chemistry B. K. Sharma, Goyal publishing house, mirut, chapter 2 relevant pages).
2. www.wikipedia.org/wiki/copy right act of 1976.
3. www.wikipedia.org/wiki/patentact
4. www.wikipedia.org/wiki/trademark
5. Insects and pesticides, Saxena A. B. Anmol Publications.
6. Emergency medicine: Chapter 146 Insecticides, Herbicides and Rodenticides by James Adams.
7. Growth regulators in Agriculture and Horticulture by Amarjit Basra CRC press, 2000.
8. Shreeves Chemical process industries (5th Edn) G. T. Oustin, MC Graw Hill.
9. Riegel's hand book of Industrial chemistry (9th Edn) Jems A. Kent.
10. Chemistry and Industrial starch New Youk, N. Y., Academic press, inc by Kerr, Ralph, Waldo Emerson.
11. The petroleum chemicals industry by R. E. Goldstine, e and fn London.
12. Fundamentals of petroleum chemical technology by P. Below.
13. Petrochemicals volume 1 and 2, A. Chauvd and Lefeurek, Gulf publishing company.

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SEMESTER V

Course/ Paper Title	**Chemistry Practical-VIII**
Course Code	**23SBCH5MVSC**
Semester	**V**
No. of Credits	**2 (60 Hours)**

Aims & Objectives of the Course: The student should be

Sr. No.	Objectives
1	Able to learn all the necessary laboratory skills needed for analysis and synthesis.
2	Able to grasp the correlation of theoretical and experimental aspects
3	Able to handle basic instruments and perform various laboratory techniques
4	Able to explain the outcomes/results of the experiments and systematically present the experimental findings with the help of graph, observation table, results, calculations and graph as per requirement.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	The student will be equipped with knowledge and skills required in Chemistry Laboratory
2	Student will be able to understand, execute and conclude the outcomes of a given experimental procedure
3	Student will be able carry out stoichiometric calculations, handle Synthesis of various organic compounds through greener approach, preparations of derivative of various functional groups and TLC technique.
4	Develop consciousness towards green chemistry practices

Syllabus

Sr. No.	Title with Contents	Practical Sessions
I	**A) Separation of Binary Mixtures and Qualitative Analysis (Any Six)** At least one mixture from each of the following should be given-Acid-Base, Acid- Phenol, Acid-Neutral, Phenol-Base, Phenol-Neutral, Base-Neutral and Neutral-Neutral. (Solid-solid mixtures to be insoluble in water)	
	a) Solid-Solid (3 Mixtures)	**3**
	b) Solid-Liquid (2 Mixtures)	**2**

	c) Liquid-Liquid (1 Mixture)	**1**
II	**B) Preparations**	
	a) Green Chemistry Preparations (Any Two)	**2**
	1. Preparation of dibenzalpropanone from benzaldehyde and acetone using $LiOH.H_2O$/NaOH and purification.	
	2. Nitration of phenol or substituted phenols using $CaNO_3$ and purification.	
	3. Bromination of acetaanilide using ferric ammonium nitrate and KBr in aqueous medium and purification.	
	b) Organic Preparations (Any Two)	**2**
	1. Preparation of 1, 4- dihydropyrimidinone from ethyl acetoacetate, benzaldehyde and urea using oxalic acid as catalyst.	
	2. Preparation p-Iodonitrobenzene from p-Nitroaniline by Sandmeyer Reaction	
	3. Preparation P-chloro benzoic acid and p-chloro benzyl alcohol from p-chloro benzaldehyde.	
	C) Preparations of Organic Derivative (Any Two)	**2**
	1. Amide derivative of carboxylic acid	
	2. Glucosazone derivative of glucose	
	3. Paracetamol from p-aminophenol	

References:

1. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
2. Vogel's Textbook of Practical Organic Chemistry
3. T.Y.B.Sc. Practical Chemistry (2019 Pattern), Manali Prakashan
4. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal

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SEMESTER-V

Course/ Paper Title	**Ancient Indian Chemistry**
Course Code	**23SBCH5IKS**
Semester	**V**
No. of Credits	**2 (30 Hours)**

Content

Unit No.	Title of Unit	No. of Hours
I	**Ancient Indian Chemistry: Technologies, and Applications**	**5**
II	**Indian Alchemy in Medicines**	**5**
III	**Metallurgy in Ancient India**	**16**
IV	**Contribution of Ancient Indian Chemists**	**4**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1.	Understand the key technologies and applications of ancient Indian chemistry and their impact on science and society.
2.	Explore the principles and practices of Indian alchemy, especially in the context of traditional medicine.
3.	Examine the development and advancements in metallurgy in ancient India and their technological significance.
4.	Analyze the contributions of notable Indian chemists to the evolution of chemical sciences through history.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1.	Know the Indian Knowledge System and its significance in the protection of traditional knowledge.
2.	Understand the need of the Indian Knowledge System (IKS) and significance of the ancient Indian Chemistry.
3.	Relate the various concepts of ancient chemistry with the concepts of modern Chemistry.
4.	Organize the contributions made by the ancient Indians in the field of science and related concepts. Evaluate the contribution of Indians in the development of chemistry.

Syllabus

Unit No.	Title with Contents	No. of Hours
I	**Chapter 1: Ancient Indian Chemistry: Technologies, and Applications** Introduction to IKS, From Alchemy to Chemistry: Early Chemical Techniques, Technology and Arts, Different Areas of Development in Ancient India: Glass Making (Literary Sources, Foreign Travellers' Account, Archaeological Evidences), Paints and Dyes, Perfumes and Cosmetics, Chemicals in Ancient India, Paper and Ink Making, Alcoholic Liquors.	05
II	**Chapter 2: Indian Alchemy in Medicines** Introduction, Rasayanas, Etymology of Rasayana, Rasayana as Elixir, The position of Rasayana in Indian medicines Charaka and two categories of medicines, Herbal Rasayanas, Metallic preparations as Rasayana, Iron as a reducing Agent, Charaka's incidental mention of a gold preparation, Calcined metals as Phlogiston, Calcined metals as alchemical preparations, Pulverization of calcined metals, Calcined gold as the ideal herbo-metallic preparation, Indian alchemy (500 A.D.), Indian alchemy (1000 A.D.)	05
III	**Chapter 3: Metallurgy in Ancient India** Primary Texts on Metallurgy in India: Rig-Veda (tr. adapted from R.T.H. Griffith), Arthaśāstra (tr. R.P. Kangle), Varāhamihira (b. ~ 485 CE), Khaḍgalakṣaṇam (tr. Vibha Tripathi), Nāgārjuna (7th or 8th century CE), Rasendramaṅgalam (tr. H.S. Sharma), Vāgbhaṭa (13th century), Rasaratnasamuccaya (tr. INSA) Classification of metals: Survarṇa (gold) : Home S.Y.B.Sc. Chemistry Syllabus as per NEP-2020 from Academic Year 2025-26 | 55 Varieties, Description of different types of suvarṇa	16

	(Prākṛta suvarṇa, Sahaja suvarṇa, Vahni sambhūta suvarṇa, Khanija suvarṇa, Rasendra vedhaja suvarṇa), Pharmaco-therapeutic properties of gold. Rajata (silver) : Varieties, Description of different types of rajata (Sahaja rajata, Khanija rajata, Kṛtrima rajata), Qualities of superior and inferior silver, Pharmaco therapeutic properties of silver Tāmra (copper): Varieties, Description of different types of tamrsa (mleccha and nepālaka tāmra), Qualities and inferior tāmra, Pharmaco-therapeutic properties of tāmra Loha (iron): Varieties, subvarieties, Pharmaco-therapeutic properties of muṇḍa loha Vaṅga (tin): Varieties, Physical properties, Pharmaco-therapeutic properties of vaṅga Nāga / śīśa (lead): Physical properties of lead, Pharmaco-therapeutic properties of lead Pittala (brass) : Varieties, Physical properties of superior pittala, Physical properties of superior and inferior properties of pittala, Pharmaco-therapeutic properties of pittala; Knowledge of Fundamental Concepts of Chemistry: Concept of atom, nano particles, metallurgy in India (extraction, Purification, alloying process): copper, iron, zinc, gold and silver, Disappearance of metallurgical skills.	
IV	**Chapter 4: Contribution of Ancient Indian Chemists** Kanada, Nagarjuna, Vagbhata, Charaka, Sushruta, Nityanatha Siddha, Govindacharya, Yashodhar, Ramchandra, Somdev, Acharya Prafulla Chandra Ray.	**04**

Reference Books:

1. Indian Alchemy or Rasayana By S. Mahdihassan https://archive.org/details/IndianAlchemyOrRasayanaByS.Mahdihassan/page/n79/mode/2up
2. History of Chemistry in ancient and medieval India Acharya Prafulla Chandra Ray (Edited by P. Ray, Indian Chemical Society, Calcutta, 1956, page no. 208-239
3. India's Glorius Scientific Tradition by Suresh Soni
4. Chapter 15- Scientists of Ancient India, https://digital.nios.ac.in/content/223en/CH.15.pdf
5. Some famous Indian Scientists by S Chandrasekhar, https://www.tifr.res.in/~outreach/biographies/scientists.pdf
6. Other source: Wikipedia https://en.wikipedia.org/wiki/List_of_Indian_scientists

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SEMESTER-VI

Course/ Paper Title	**Physical Chemistry-II**
Course Code	**23SBCH61MM**
Semester	**VI**
No. of Credits	**2 (30 Hours)**

Content

Sr. No.	Chapter Title	No. of Hours
1.	Electrochemical Cells	07
2.	Applications of Electrochemical Cells	05
3.	Crystal Structure	08
4.	Colligative properties of dilute solutions	10

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1.	Fundamentals of electrochemical cells and electrodes, Applications of emf measurements, Batteries and Fuel cells.
2.	Concept of crystallography, different Lattices, Unit cell of crystals, and methods of analysis of crystal Structure.
3.	Meaning of the terms- colligative properties and various application of colligative properties in physical chemistry.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1.	**Unit I:** After Studying Electrochemical cells student will able to learn: - 1. Fundamentals of Electrochemical cells: Daniel cell, Conventions to represent electrochemical cells 2. Thermodynamic conditions of reversible cell, Explanations of reversible and irreversible electrochemical cell with suitable example, 3. EMF of electrochemical cell and its measurement. 4. The Weston standard cell

	5. The primary reference electrode: The standard hydrogen electrode (SHE) with reference to diagram, Construction, representation, working and limitation, 6. Secondary reference electrodes: (a) The calomel electrode, (b) The glass electrode (c) The silver-silver chloride electrode. Understanding of these electrodes with reference to diagram, representation, Construction, working 7. Nernst Equation for theoretical determination of EMF 8. Types of Reversible electrodes: Metal-metal ion electrodes, Amalgam electrodes, Gas electrodes, Metal-metal insoluble salt electrodes, Oxidation-reduction electrodes with respect to examples, diagram, representation, construction, working (electrode reactions) and electrode potential. 9. Sign convention for electrode potentials and Electrochemical series 10. Standard electrode potentials, 11. Types of concentration cells: Concentration cells without and with transference Concentration cells with liquid junction potential 12. Liquid junction potential and salt bridge
2.	**Unit II:** After Studying Electrochemical cells student will able to learn: - 1. Applications of emf measurements: 1. Determination of pH of a solution by using hydrogen electrode, quinhydrone electrode and glass electrodes 2. Potentiometric titrations: i) Acid-base titrations, (ii) Redox titrations and (iii) Precipitation 2. Primary Batteries: Dry Cells, alkaline batteries with respect to construction, diagram and working 3. Secondary Batteries: Nickel-cadmium, Lithium-ion batteries, the lead acid battery with respect to construction, diagram and working 4. Applications for Secondary Batteries 5. Fuel Cells: Types of fuel cells, advantages, disadvantages of these fuels cells, comparison of battery Vs fuel cell 6. Solve / discuss the problem based on Nernst equation and thermodynamics of emf.
3.	**Unit III:** After Studying Crystal Structure student will able to learn: - 1. Distinguish between crystalline and amorphous solids / anisotropic and isotropic solids. 2. Explain the term crystallography and laws of crystallography. 3. Weiss and Millers Indices, determination of Miller Indices 4. Bravais lattices, space groups, seven crystal systems and fourteen Bravais lattices; 5. Cubic lattice and types of cubic lattice 6. Distance between the planes for 100, 110 and 111 for cubic lattice 7. The Laue and Braggs methods: Derivation of Bragg's equation, 8. Determination of crystal structure of NaCl by Bragg's method, 9. X ray analysis of NaCl crystal system and Calculation of d and λ for a crystal system, 10. Solve / discuss the problem based on Bragg's equation.

4.	**Unit IV:** After Studying the colligative properties of dilute solutions student should be able: - 1. To define Solution, electrolytes and non-electrolytes. 2. To understand the term colligative property. 3. To learn Lowering of vapour pressure of solvent in solution, Elevation of B.P. of solvent in solution, Freezing point depression and Osmotic pressure. To understand the application of colligative properties to determine molecular weight of nonelectrolyte, abnormal molecular weight.

Syllabus

Unit No.	Title With Content	No. of Hours
I	**Electrochemical cells:** Introduction, reversible and irreversible cells with examples, The e.m.f. of electrochemical cell and its measurement, The Weston standard cell, Reference electrodes, The primary reference electrode and Secondary reference electrodes, The Nernst equation for E.M.F. of a cell. Types of reversible electrodes, the sign convention for electrode potentials, E.M.F. and equilibrium constant of cell reaction, Electrochemical series, Types of concentration cells, liquid junction potential, salt bridge, Numerical problems Ref.-1: 1154-1178 Ref.-2: 835-880	07
II	**Applications of Electrochemical Cells:** Determination of pH of a solution by using hydrogen electrode, quinhydrone electrode and glass electrodes 2. Potentiometric titrations: i) Acid-base titrations, (ii) Redox titrations. (iii) Precipitation titration, Numerical problems. **Batteries:** Primary and Secondary batteries, applications for Secondary Batteries. **Fuel Cells:** Types of fuel cells, advantages, disadvantages of fuels cells, comparison of battery versus fuel cell. Ref.-3: 320-412 Ref-4: 1789-1888	05
III	**Crystal Structure:** Introduction, Types of Solids, Isotropy and Anisotropy, Laws of crystallography: Law of constancy of interfacial angles, Law of rational indices, Law of crystal symmetry, Weiss indices and Miller indices, Crystal Structure: Parameters of the Unit Cells, Cubic Unit Cells: Types of Cubic Unit Cells, Calculation of Mass of the Unit Cell, Methods of Crystal structure analysis: The Laue method and Braggs method: Derivation of Bragg's equation, Determination of crystal structure of NaCl by Bragg's method, X ray analysis of NaCl crystal system, Calculation of d and λ for a crystal system, Numerical problems.	08

	Ref.-1: 491-507, 518-528 Ref.-2: 1165-1180	
IV	**Colligative properties of dilute solutions:** Introduction, Solution, electrolytes and nonelectrolytes, Meaning of term colligative property, relative lowering of vapour pressure of solvent in solution, elevation of B.P. of solvent in solution, Landsberger's method, freezing point depression, Beckmann's method, Osmosis and Osmotic pressure, Berkeley and Hartley method, application of colligative properties to determine molecular weight of nonelectrolyte, abnormal molecular weight, Relation between Vant Hoff's factor and degree of dissociation of electrolyte by colligative property, problems. Ref. 2**:** Page No. 778 – 800. Ref. 5**:** Page No. 614 – 684.	10

Reference Books:

1. Essentials of Physical chemistry by Bahl and Tuli-Revised Multicolour Edition 2009, S. Chand and Company Ltd.
2. Principles of physical chemistry by B.R. Puri, L.R. Sharma, M.S. Pathania
3. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000.
4. Modern Electrochemistry Second Edition by John O'M Bockris, Molecular Green Technology College Station, Texas and Amulya K. N. Reddy, President International Energy Initiative Bangalore, India
5. Essentials of Physical chemistry by Bahl Tuli-Revised Multicolour Edition 2009, S. Chand and Company Ltd.

Additional References:

1. Physical Chemistry by G. M. Barrow, International student Edition, Mc Graw Hill.
2. University General Chemistry by C.N.R. Rao, Macmillan.
3. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
4. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
5. Principles of Physical Chemistry by S. H. Maron, C. H. Prutton, 4th Edition.
6. Modern Electrochemistry Second Edition by John O'M Bockris.

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SEMESTER-VI

Course / Paper Title	**Inorganic Chemistry-II**
Course Code	**23SBCH62MM**
Semester	**VI**
No. of Credits	**02 (30 Hours)**

Content

Unit No.	Chapters with contents	No. of lectures
I	**Metals, Semiconductors and Superconductors**	**08**
II	**Homogeneous and Heterogeneous catalysis**	**08**
III	**Chemical Toxicology**	**04**
IV	**Inorganic Polymers**	**04**
V	**Ionic Solids**	**06**

Aims & Objectives of the Course:

Sr. No.	Objectives
1	To understand the nature of metallic bonds with the help of free electron theory and the band theory. To understand the differences between metals, semiconductor, and insulators based on band theory. To know about N (E) curves and electrical conductivity of metals. To know about the discovery and applications of superconductors
2	To understand the phenomenon of catalysis, types of catalysis, homogeneous and heterogeneous catalysis, role of Zeolites in catalysis, biodiesel synthesis, automotive exhaust catalysts and to understand the role of catalysts and catalytic reactions used in industries.
3	To know toxic chemical in the environment and impact of toxic chemicals on enzyme.
4	To know about inorganic polymers and their types. To know the synthesis, structures of inorganic polymers and their use.
5	To know the nature of solids and the crystal structures of solids. To study the simple cubic, BCC and FCC crystal structures. To know about the Pauling's univalent and crystal radii. To study Born-Haber cycle to calculate lattice energy of a crystal.

Expected Course Specific Learning Outcomes:

Sr. No.	Specific Learning Outcomes
1	**Unit I:** **Students should be able to:** 1. The meaning of metals, semiconductors, and superconductors. 2. The difference between metal, semiconductor, and insulator. 3. Metallic bond based on band theory. 4. The energy band and energy curve. Draw n (E) & N (E) curves. 5. Explain the electrical conductivity of metals with respect to valence electrons. 6. Explain the effect of temperature and impurity on conductivity of metals and semiconductors 7. Intrinsic and extrinsic semiconductor. 8. The term valance band and conduction band. n-type and p-type of semiconductors. 9. Non-stoichiometry and semi conductivity. Insulators based on band theory. 10. The difference between Na, Mg, and Al in terms of valence electrons and conductivity. 11. Meaning of super conductors and their structure 12. Discovery and applications of superconductors
2	**Unit II:** **Students should be able to:** 1. Understand the phenomenon of catalysis, its basic principles, and terminologies. 2. Define and differentiate homogeneous and heterogeneous catalysis. 3. Give examples and brief account of homogeneous catalysts. 4. Understand the essential properties of homogeneous catalysts-Give the catalytic reactions for Wilkinson's Catalysis, hydroformylation reaction, Monsanto acetic acid synthesis, Heck reaction. 5. Understand the principle of heterogeneous catalyst and development in it with examples of heterogeneous catalysts. 6. Understand the classification and essential properties of heterogeneous catalysts. 7. Give the brief account of Hydrogenation of olefins, zeolites in catalysis, biodiesel synthesis, Automotive Exhaust catalysts. 8. Understand the catalytic reactions used in industries around.
3	**Unit III : Students should be able to:** 1. To know toxic chemical in the environment. 2. To know the impact of toxic chemicals on enzyme. 3. To know the biochemical effect of Arsenic, Cd, Pb, Hg. 4. To explain biological methylation.
4	**Unit IV:** **Students should be able to:** 1. Know thy types of Inorganic polymers. 2. To compare inorganic polymers with organic polymers. 3. To know the synthesis, structural aspects of inorganic polymers. 4. To understand the polymers of Si, B, Si and P. 5. Know the uses of inorganic polymers.
5	**Unit V:** **Students should be able to:** 1. Know the nature of solids and the different types of crystal structures of solids. 2. Draw cubic, BCC and FCC crystal structures.

	3. Identify the coordination number of an ion in an ionic solid. Identify the types of voids. 4. Know the effect of radius ratio in determining the crystal structure. To define Pauling's univalent radius and crystal radius. 5. Be able to solve the problems based on Pauling's univalent radii and crystal radii. 6. Know how to draw Born-Haber cycle and to solve problems based on Born- Haber cycle. 7. Know the defects in ionic solids. To understand various types of crystal defects

Syllabus:

Unit No.	Chapters with contents	No. of Lectures
I	**Metals, Semiconductors and Superconductors:** Introduction, Metallic bonding, Band theory in metals with respect to Na along with n (E) and N(E) diagrams, Electrical conductivity of metals (Na, Mg, Al), Valence electrons and conductivity of metals, Effect of temperature and impurity on electrical conductivity of metals, Chemistry Semiconductors, types of Semiconductors: I. Intrinsic II. Extrinsic, effect of temperature and impurity on semiconductivity, n-type & p-type semiconductors ZnO and NiO, Superconductivity: Discovery, property, models, structure and superconductivity, low and high temperature superconductors, applications of superconductors. **Ref. 1 Page No.: 394-411** **Ref. 2 Page No.: 359-391** **Ref. 3 Page No.: 209-22**	**08**
II	**Homogeneous and Heterogeneous Catalysis:** Introduction to catalysis, basic principles, activity and selectivity in catalysis, types of catalysis, homogeneous vs. heterogeneous catalysis, importance of catalysis in the synthesis of high value chemicals. Homogeneous catalysis: catalytic cycles for following reactions: a) Hydrogenation of olefins using Wilkinson complex, b) Hydroformylation of olefins using Cobalt and Rhodium complexes, c) Carbonylation reaction: methanol to acetic acid process i.e., Monsanto processes and d) C-C coupling reactions: Heck reaction. Heterogeneous catalysis: History of the development of industrial heterogeneous catalysis, Classification of heterogeneous catalysts, supported metal catalyst, Role of support, Promoters and Poisons. Catalytic processes viz., a) Hydrogenation of olefins using Raney Nickel catalyst, b) Zeolites in catalysis: Catalytic cracking, c) Biodiesel synthesis using Heteropolyacids (HPAs) d) Automotive Exhaust catalysts: The catalytic converters. [Further reading: Student should also read about advanced development in the field of homogeneous and heterogeneous Catalysis.] **Ref.2 Page No. 690-721** **Ref.3 Page No.13-23, 55-61,85-102, 161-163** **Ref.4 Page No. 1-16, 87-112, 203-205, 222-224.**	**08**
III	**Chemical Toxicology:** Toxic chemicals in the environment, Impact of toxic chemistry on enzymes. Biochemical effect of Arsenic, Cadmium, Lead and Mercury. Biological methylation. **Ref:8(**75-100)	**04**

IV	**Inorganic Polymers:** Introduction, Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicates, silicones, siloxanes, borazines, and phosphazenes. **Ref. 8 PageNo. 110-129, 179-186, 207-217.**	**04**
V	**Ionic Solids:** Crystalline and amorphous solids, crystal structures simple cubic, body centered cubic and face centered cubic, Properties of ionic solids, packing arrangements of anions in an ionic solids, Voids in crystal structure-tetrahedral and octahedral, Ionic radius, Palings univalent and crystal radii, Conversion of univalent radii to crystal radii, problems based on conversion of radii, Radius ratio effect, Lattice energy, Born-Lande equation, Born Haber cycle and its applications, Schottky and Frenkel defect.(AgCl, ZnO, FeO) **Ref No.9 Page No.: 32-61** **Ref No. 10 Page No.: 102-127** **Ref No. 11 Page No.: 52-62**	**06**

Reference Books:.

1. Solid State Chemistry: An Introduction, Lesley E. Smart, Elaine A. Moore, 3rd Edn
2. Solid State Chemistry and its Applications, Anthony R. West, Second Edition, Wiley 2014
3. New Guide to Modern Valence Theory by G.I. Brown - 3 rd edition
4. Heterogeneous catalysis in industrial practice, Chaerls N. Shatterfield, 2nd Edition, Krieger Publishing Company, Florida USA.
5. Concise Inorganic Chemistry by J. D. Lee - 5th edition.
6. Inorganic Chemistry by D. F. Shiver & P.W. Atkins- C.H. Longford ELBS- 2nd Edition.
7. Principles of Bioinorganic Chemistry by S. J. Lippard and J. M. Berg, Panima Publishing Corporation, 1st Edition.
8. Environmental chemistry by A.K.De Publisher- Wiley Eastern Limited New Age International Limited Page No. 75-100.
9. Concise Inorganic Chemistry by J.D. Lee - 5th edition
10. Concept and Model of Inorganic Chemistry by Douglas–Mc Daniels - 3rd edition
11. New Guide to Modern Valence Theory by G.I. Brown - 3rd edition

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SEMESTER-VI

Course/ Paper Title	**Organic Chemistry-II**
Course Code	**23SBCH63MM**
Semester	**VI**
No. of Credits	**2 (30 Hours)**

Content

Unit No.	Title	No. of Lecture
I	**Introduction to Spectroscopy**	**02**
II	**Ultra-Violet and Visible Spectroscopy**	**06**
III	**Infra-Red Spectroscopy**	**08**
IV	**Nuclear Magnetic Resonance Spectroscopy (PMR)**	**08**
V	**Combined problems on U.V., I.R. and PMR spectroscopy**	**06**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1	To develop fundamental understanding of spectroscopy, energy radiations and range of energy radiations for various spectroscopies.
2	To develop the fundamentals of uv-vis spectroscopy, make students solve numerical problems and determine λ_{max}.
3	To develop the basics of infrared spectroscopy with respect to fundamental modes of vibrations, IR Frequencies of functional groups.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit I: Introduction to Spectroscopy** The students will be able to understand the nature of electromagnetic radiation, relationship of energy and wavelengths. The perception of nature of interaction of radiation with molecules will be helpful in understanding various types of spectroscopies.

2	**Unit II: Ultra Violet and Visible Spectroscopy** The students will be able to understand the ultraviolet and visible spectroscopy with respect to chromophores, auxochromes. They shall be learning problem solving and determine λ_{max}.
3	**Unit III: Infra-Red Spectroscopy** The students will be able to understand the vibration of various bonds and interaction of IR radiation with the different types of bonds present in various functional groups. They shall be able to determine the presence of various functional groups based on frequencies.
4	**Unit IV: Nuclear Magnetic Resonance Spectroscopy (PMR)** The students will be able to understand the fundamental concepts in nuclear magnetic spectroscopy like its principles, Magnetic and nonmagnetic nuclei, nuclear resonance, chemical shift, integration, spin-spin coupling, coupling constants, J-value and other related concepts.
5	**Unit V: Combined problems based on U.V., I.R. and PMR spectroscopy** The students will get to learn problem solving skills. Deduce structures of organic compounds on the basis of MF, UV, IR and NMR Data.

Syllabus

Unit No.	Title with Contents	No. of Lectures
I	**Introduction to Spectroscopy** Introduction, meaning of spectroscopy, Types of spectroscopies, nature of electromagnetic radiation and regions of electromagnetic spectrum, Terms used in spectroscopy; wavelength, amplitude, frequency, wavenumber, energy and their relations and conversions **Ref. 1 Page No.: 01-06**	**02**
II	**Ultra-Violet and Visible Spectroscopy** Introduction, Electromagnetic radiations, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic and hypsochromic shifts, Application of visible, ultraviolet spectroscopy in organic molecules. Application of electronic spectroscopy and Woodward rules for calculating λ_{max} of conjugated dienes and α,β-unsaturated compounds. **Ref. 2 Page No.: 367-400**	**06**
III	**Infra-Red Spectroscopy** Introduction, Infrared radiation and types of molecular vibrations, functional groups and fingerprint region. Infra-red spectroscopy in organic molecules, IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions). **Ref 2 Page No.: 28-175**	**08**
IV	**Nuclear Magnetic Resonance Spectroscopy (PMR)** Introduction, Principles, Magnetic and nonmagnetic nuclei, nuclear resonance, chemical shift, shielding, & de-shielding effect. Measurement of chemical shift, TMS as reference and its advantages, peak area,	**08**

	integration, spin-spin coupling, coupling constants, J-value, problems based on NMR. **Ref. 2: Page Nos. 176-282**	
V	**Combined problems based on U.V., I.R. and PMR spectroscopy**. **Ref. 1 and Ref. 2:** Problems to be selected and framed from relevant pages.	**06**

Reference Books:

1. Jagdamba Singh; Jaya Singh Organic Spectroscopy Principles, Problems and Their Solutions, First Edition 2016, Pragati Prakashan, 978-93-86104-4-0
2. Pavia D. L.; Lampman G. M. Kriz G. S.; Vyvyan J.R. Introduction to Spectroscopy, Third Indian Reprint, 2010, ISBN: 978-81-315-0576-2

Additional Reference:

1. P. S. Kalsi, Spectroscopy of Organic Compounds, VII Edition, New Age International Publishers
2. Spectrometric Identification of Organic Compounds, David J. Kiemle, David L. Bryce, Francis X. Webster, Robert M. Silverstein, VII Edition, Wiley

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SEMESTER-VI

Course/ Paper Title	**Chemistry Practical-IX**
Course Code	**23SBCH64MM**
Semester	**VI**
No. of Credits	**2 (60 Hours)**

Aims & Objectives of the Course: The student should learn:

Sr. No.	**Objectives**
1	Experimental aspect of electrochemical cells and its construction
2	Understanding of pH metric techniques through its experimental method
3	Applications of colligative properties for electrolytes and non-electrolytes
4	Principle of turbidimetry and viscosity measurement through its experimental method
5	Analysis of experimental X-ray diffraction spectra

Expected Course Specific Learning Outcomes

Sr. No.	**Specific Learning Outcomes**
1.	To understand the principle and applications of potentiometric technique.
2.	To investigate the degree of hydrolysis of salt, dissociation constant, strength and isoelectric point of different acids.
3.	To understand the principle and applications of colligative properties for the estimation of molecular mass and abnormal molecular mass of non-electrolytes and electrolytes.
4.	Applications of turbidimetric and viscosity measurement techniques for the qualitative and quantitative estimations
5.	Analysis of experimental powdered X-ray diffraction pattern for the crystals of strontium titanate or silver atom.

Syllabus

Sr. No.	**Title with Contents**	**Practical Sessions**
	Section A: Potentiometry: (Any Three)	

1.	To prepare standard 0.2 M Na_2HPO_4 and 0.1 M Citric acid solution, hence prepare four different buffer solutions using them. Determine the pH value of these and unknown solution	1
2.	To determine the PKa value of given monobasic weak acid by potentiometric titration.	1
3.	To determine the formal redox potential of Fe^{2+}/ Fe^{3+} system potentiometrically.	1
4.	To determine the amount of NaCl in the given solution by potentiometric titration against silver nitrate.	1
6.	To estimate the amount of chloride (Cl^-) and iodide (I^-) in given unknown halide mixture by titrating it against standard $AgNO_3$ solution.	1
	Section B: pH metry (Any Two)	
7.	To determine the degree of hydrolysis of aniline hydrochloride.	1
8.	To determine the Pka of given weak acid by pH metry titration with strong base	1
9.	To determine the dissociation constant of oxalic acid by pH-metric titration with strong base	1
10.	To perform pH metric titration of strong acid against strong base and hence to determine the concentration and strength of strong acid.	1
	Section C: Colligative Properties of Dilute Solution (Any One)	
11.	To determine the molecular weight of solute by depression in freezing point method.	1
12.	To determine the molecular weight of given electrolyte and non-electrolyte by Landsberger's method and to study the abnormal molecular weight of electrolyte.	1
	Section D: Turbidometry and Viscometry: (Any One)	
13.	To determine the amount of sulphate (SO_4^{2-}) and chloride (Cl^-) by turbidimetric method (turbidimetric titration or calibration curve method)	1
14.	To determine the radius of glycerol molecule from viscosity measurement.	1
	Section E: Table Work (Compulsory)	
15.	Analysis of crystal structure from X-ray diffraction spectra of strontium titanate or silver atom (Calculation d, lattice constant, crystal volume and density, and assigning planes to peaks using JCPDS data)	1
	Section F: Inorganic Compulsory Experiment (Any Four)	
16.	Determination of the metal to ligand ratio (M : L) in complexes.	1
17.	To study Fenton reaction: Degradation of H_2O_2 using Fe catalyst.	1
18.	Verification of periodic trends using solubility of alkaline earth metal hydroxides Ca(OH)2,Mg(OH)2, Cr(OH)2, Ba(OH)2.	1
19.	Estimation of Na by flame photometry by calibration curve method	1
20.	Synthesis of amine complexes of Ni (II) and its ligand exchange reaction by substitution method. (bidentate ligands like acac, DMG, Glycine).	1

References:

1. Practical physical chemistry, A. Findlay, T.A. Kitchner (Longmans, Green and Co.)
2. Systematic experimental physical chemistry, S. W. Rajbhoj, T. K. Chondekar, Anjali publication.
3. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Garg (R. Chand and Co., Delhi.)
4. Advanced Practical Chemistry, Jagdamba Sing et al, Pragati Prakashan, Merrut.
5. Experimental Physical Chemistry by D. P. Shoemaker, Mc. Growhill, 7th Edition, 2003.
6. Physical chemistry by Wien (2001)
7. Advance Physical Chemistry Experiment, Gurtu and Gurtu, Pragati Publication (Meerut),
8. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
9. Practical physical Chemistry, B. Vishwanathan and P. S. Raghwan, Viva Books
10. Experimental Physical Chemistry, Halpern, A. M. & McBane, G. C. 3rd Ed.; W.H. Freeman & Co.: New York (2003).
11. T. Y. B. Sc. Practical Chemistry (2019 Pattern), Manali Prakashan

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SEMESTER VI

Course/ Paper Title	**Chemistry Practical-X**
Course Code	**23SBCH65MM**
Semester	**VI**
No. of Credits	**2 (60 Hours)**

Aims & Objectives of the Course: The student should be

Sr. No.	Objectives
1	Able to learn all the necessary laboratory skills needed for analysis and synthesis.
2	Able to grasp the correlation of theoretical and experimental aspects
3	Able to handle basic instruments and perform various laboratory techniques
4	Able to explain the outcomes/results of the experiments and systematically present the experimental findings with the help of graph, observation table, results, calculations and graph as per requirement.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**A) Organic Estimations** The students will be able to Practical knowledge of handling chemicals. Achieve the practical skills required to estimations of glucose and glycine. Achieve the practical skills required to Saponification value of oil. Determine the molecular weight of given tribasic acids.
2	**B) Organic Extractions** The students will be able to Apply the principles of extraction Understand the equipment for extraction. Gain practical hands-on experience of modern Extraction. Develop basic design of extractor Describe the extraction separation process.
3	**C) Column Chromatography** The students will be able to Defines the basic parameters in chromatography Explain the processes of a chromatography analysis Describes the types and materials of column. Explains the types of mobile phase and elution. Realize the selection of appropriate mobile phase, column and detector
4.	

Syllabus

Sr. No.	Title with Contents	Practical Sessions
	Section A: Organic Estimations (Any Three)	
1.	Estimation of glucose	1
2.	Estimation of glycine	1
3.	Saponification value of oil	1
4.	Estimation of Alkali content in Antacid using HCl.	1
	Section B: Organic Extractions (Any Three)	
5.	Caffeine from tea leaves	1
6.	Eugenol from cloves	1
7.	Lycopene from tomato peels	1
8.	Cinnamic acid from cinnamon	1
9.	Trimyristin from nutmeg	1
	Section C: Column Chromatography (Two)	
10.	Separation of mixture of aldehyde and carboxylic acid by column chromatography	1
11.	Separation of mixture of O-nitrophenol and P-nitrophenol by column chromatography	1
	Section D: Inorganic Chemistry Practical (Any Four)	
12.	Analysis of Phosphate (PO_4^{3-}) from Fertilizer.	1
13.	Estimation of Cu by Iodometry from copper complex.	1
14.	Analysis of Calcium from milk powder.	1
15.	Analysis of Iodine from Iodized salt.	1
16.	Estimation of NO_2 - by using $KMnO_4$.	

References:

1. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House Vogel's Textbook of Practical Organic Chemistry
2. T.Y.B.Sc. Practical Chemistry (2019 Pattern), Manali Prakashan
3. Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Renu Aggarwal

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SEMESTER VI

Course/ Paper Title	**Bioanalytical Chemistry (Major Elective)**
Course Code	**23SBCH66MEA**
Semester	**VI**
No. of Credits	**2 Credits (30 Hours)**

Content

Unit No.	Chapters with contents	No. of lectures
I	**Biological Samples**	**04**
II	**Analysis of Blood and Urine**	**10**
III	**Determination of Vitamins in Blood**	**04**
IV	**Bioanalysis Techniques**	**12**

Aims & Objectives of the Course

Sr. No.	Objective
1	The primary objectives of this course are to develop the skills to understand the theory and practice of bio analytical techniques.
2	To provide scientific understanding of analytical techniques and detail interpretation of results.
3	Expanding the understanding of the role, importance and application areas of bioanalytical chemistry.
4	Broadening the knowledge base about the specificities of sampling and preparing biological samples, as well as about methods of bioanalytical chemical investigations

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1	**Unit I:** After studying this unit student will able to: - 1. Explain the collection of bioanalytical samples. 2. Explain the composition of blood, urine and faeces. 3. Describe the storage and preservation of bioanalytical samples for analysis
2	**Unit II:** After studying this unit student will able to: - 1. Understand the methodology for the selection of suitable measurement techniques and methods to solve complex bioanalytical problems. 2. Understand the strengths, limitations, and creative use of techniques for

	problem-solving. 3. Analyse different bioanalytical samples for their composition and interpret the results. 4. Design experiments and understand the instrumentation.
3	**Unit III:** After studying this unit student will able to: - 1. Understand the importance and role of each vitamin. 2. Analyse different bioanalytical samples for their composition and interpret the results. 3. Design experiments and understand the instrumentation.
4	**Unit IV:** After Studying this unit student will able to: - 1. Develop the skills to understand the theory and practice of bioanalytical techniques. 2. Explain principles of different analytical techniques. 3. Explain the working and instrumentation of different bioanalytical techniques.

Syllabus

Unit No.	Name of the Topic	Lectures
I	**Biological Samples:** Blood: Collection of blood specimens, storage and preservation. Urine: Collection of urine specimens, physical characteristics of urine, preservation and storage. Faeces: Collection and preservation. **Ref No. 1 Page No.: 1-18** **Ref No. 1 Page No.: 7-19**	**02**
II	**Analysis of Blood and Urine:** Blood Analysis: Determination of glucose, cholesterol, urea and uric acid. Estimation of Na, K, Ca by flame photometry. Oral Glucose tolerance test. Urine Analysis: Determination of glucose, urea and creatinine. Analysis of normal and abnormal constituents of urine. Numerical problems **Ref No. 1 Page No.: 80, 97, 110, 158, 190, 431**	**08**
III	**Determination of Vitamins in Blood:** Classification of vitamins with example, Each vitamin must be explained with respect of functions, deficiency diseases. Analytical method of Vitamin B1 (thiamine determination by fluorometry), Vitamin B2 (riboflavin, Photo-fluorometric method), Vitamin B6 (Pyidoxine, Fluorometric determination of Xanthuric acid), Ascorbic acid (vitamin – C) Volumetric method using 2,6-dichloroindophenol method. **Ref. 1 and 5: Relevant Pages**	**08**
IV	**Bioanalysis Techniques:** Principle, working & applications of a) Colorimetry b) Spectrophotometry c) Flame Emission Spectroscopy d) Atomic absorption spectroscopy e) Paper chromatography, f) Thin layer chromatography (TLC) g) Gas chromatography	**12**

	and h) High performance liquid chromatography (HPLC). Numerical problems. **Ref No. 3 Page No.: 119-252, 695-780** **Ref No. 4 Page No.: 3-89, 285-324**	

References:

1. Practical clinical Biochemistry, Harold Varley (4th Edition), CBS publishers and Distributers. New Delhi -110002
2. Practical Clinical Biochemistry Methods and Interpretations, 4th Edition by Ranjna Chawla, Jaypee Brothers Medical Publishers, New Delhi.
3. Principles of Instrumental Analysis, 7th Edition by Douglas A. Skoog, F. James Holler and Stanley R. Crouch, Cengage Learning 20 Channel Center Street Boston, MA 02210 USA
4. Chemical Analysis Modern Instrumentation Methods and Techniques, 2nd Edition, Francis Rouessac and Annick Rouessac, John Wiley & Sons Inc., 111 River Street, Hoboken, NJ 07030, USA.
5. Basic Concepts in Clinical Biochemistry: A Practical Guide by Vijay Kumar and Kiran Dip Gill, Springer Nature Singapore Pvt. Ltd. 2018.

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SEMESTER-VI

Course/ Paper Title	**Chemistry of Biomolecules (Major Elective)**
Course Code	**23SBCH66MEB**
Semester	**VI**
No. of Credits	**2 (30 Hours)**

Unit No.	Title of Topic/Chapter	No. of Hours
I	**Introduction Origin, aim and scope of Biochemistry**	**03**
II	**Amino acids and Protein**	**06**
III	**Nucleotides and Nucleic acids**	**06**
IV	**Carbohydrates**	**06**
V	**Lipids**	**06**
VI	**Vitamins**	**03**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1	To understand the fundamental principles of biochemistry, its origin, and its interdisciplinary role in explaining the molecular basis of life.
2	To explore the structure, properties, and biological significance of amino acids and proteins as vital biomolecules in cellular functions.
3	To study the structure and functions of nucleotides and nucleic acids in the storage and transmission of genetic information.
4	To understand the classification, structure, and roles of carbohydrates as energy sources and structural components in living organisms.
5	To explore the structure, classification, and biological significance of lipids in energy storage, membrane formation, and signalling.
6	To understand the biochemical roles of vitamins in metabolism and their importance in maintaining health and preventing deficiencies.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit I:** After Studying the Introduction of Biochemistry student will able to learn: - 1. Trace the historical development of biochemistry and its impact on various scientific fields. 2. Explain the aim and scope of biochemistry in understanding the molecular mechanisms of life processes. 3. Describe the molecular structure of water and its unique properties such as polarity, hydrogen bonding, and cohesion. 4. Explain the significance of water in biological systems, including its role as a solvent, temperature regulator, and reactant in biochemical processes.
2	**Unit II:** After studying Amino acids and Protein student will able to learn: - 1. Understand that amino acids contain carbon, nitrogen, oxygen and hydrogen atoms, some contain an atom of sulphur and that there are about 20 different amino acids, with different sidechains (R groups) 2. Understand that amino acids are linked via peptide bonds to make polypeptides and proteins understand that each protein molecule can be hundreds of amino acids long and the amino acids must be joined in a precise order, which is specified by a code in the DNA in the chromosomes 3. Understand that the sidechains (R groups) of the amino acids can interact with one another to fold the protein into a particular shape which is essential for the protein to function correctly.
3	**Unit III:** After studying Nucleotides and Nucleic acids student will able to learn: - 1. Describe the structure of a nucleotide as being a phosphate group, pentose sugar (either ribose or deoxyribose), and a nitrogen containing base, 2. Recall that the nitrogenous bases are adenine, cytosine, guanine, and thymine in DNA, or uracil in RNA, and the base pairings that occur, 3. State that a nucleic acid is formed from many nucleotides, joined by condensation reactions, 4. Compare and contrast the structures of DNA and RNA, 5. Explain the importance of DNA in storing genetic material and safely transferring genetic information between organisms.
4	**Unit IV:** After studying Carbohydrates student will able to learn: - 1. State the general formula of monosaccharides as $(CH_2O)_n$, 2. Recall the classification of carbohydrates into simple sugars (mono- and disaccharides) and complex sugars (polysaccharides), 3. Describe the alpha and beta structures of glucose and its properties as a hexose sugar, 4. Outline the synthesis and breakdown of disaccharides including maltose, sucrose, and lactose, 5. Describe the structure and function of glucose, starch, glycogen, and cellulose, 6. Explain the role of monosaccharides in the processes of transferring energy inside the cells of living organisms.
5	**Unit V:** After studying Lipids student will able to learn: - 1. Outline the structure of a triglyceride and phospholipids, 2. Describe the synthesis and breakdown of triglycerides, 3. Compare the structure of saturated and unsaturated fatty acids,

	4. Describe the properties of triglyceride, phospholipid, and cholesterol molecules and relate them to their functions in organisms, 5. Recall that lipids can be classified into simple, complex, and derived lipids.
6	**Unit VI:** After studying Vitamins student will able to learn: - 1. Know the classifications and properties of the vitamins group. 2. Understand the structure of each vitamin. 3. Understand the role of each vitamin in metabolism 4. Know the symptoms of vitamin deficiency. 5. Acknowledge the new nutritional pyramid & the importance of healthy eating.

Syllabus

Unit No.	Title with Contents	No. of Hours
I	**Introduction: Origin, aim and scope of Biochemistry:** **Properties of water**: Structure and properties of water, importance of water in biological systems, Ionic product of water. **Ref 1- Page 1, 47-74** **Ref 2- Pages 2-4, 23-36** **Ref 4- Page 1**	**03**
II	**Amino acids and Protein:** Amino acids: Structure, Classification, and physico-chemical properties of amino acids, role of non-protein amino acids, peptides, peptides of physiological significance, peptide bond. Proteins: Structural features of proteins and their biological functions a. Primary Structure: Peptide bond, importance of primary structure. b. Secondary structure: alpha-helix, β - structure, β-helix, super secondary structure. c. Tertiary Structure: Forces stabilizing, unfolding/ refolding d. Quaternary structure – Haemoglobin. **Ref 1- Pages 75-85, 89-164** **Ref 2- Pages 80-97, 718-772, 97-180, 982-1032** **Ref 4- Pages 53-99, 76-130**	**06**
III	**Nucleotides and Nucleic acids:** Structure and properties of nucleotides, nucleosides, purine (Adenine, Guanine) and pyrimidine (Cytosine, Thiamine, Uracil) bases. Structural features of nucleic acids (DNA & RNA) and their biological functions. **Ref 1- Pages 281-308,** **Ref 2- Pages 42-79, 802-878** **Ref 4- Pages 198-219**	**06**
IV	**Carbohydrates:** Structure, stereochemistry, reactions and functions of monosaccharides, disaccharides polysaccharides and complex carbohydrates; amino sugars, proteoglycans and glycoproteins. **Ref 1- Pages 799-832** **Ref 2- Pages 221-244** **Ref 4- Pages 311-339**	**06**
V	**Lipids:** Classification, structure and function of major lipid subclasses- Triacylglycerols, Phospholipids, Sphingolipids, glycolipids, Lipoproteins, chylomicrons, LDL, HDL and VLDL, steroids,	**06**

	prostaglandins and bile acids, rancidity. Formation of micelles, monolayers, bilayer, liposomes. **Ref 1- Pages 357-384,** **Ref 2- Pages 245-291, 664-717** **Ref 4- Pages 153-185**	
VI	**Vitamins:** Structure and Classification, water soluble and fat-soluble vitamins. **Ref 1- Page 42**	**03**

Reference Books:

1. Nelson, D. L.; Cox, M. M.; Lehninger Principles of Biochemistry, W.H.Freeman; 2017, 7th Edition.
2. Voet, D.; Voet, J. G.; Pratt, C. W.; Fundamentals of Biochemistry, John Wiley & Sons Inc., 2016, 5th Edition.
3. Berg, J. M.; Stryer, L.; Tymoczko, J. L.; Gatto, G. J.; Biochemistry; W.H Freeman; 2019, 9th Edition
4. Kuchel, P.; Easterbrook, S.; Gysbers, V.; Guss, J. M.; Hancock, D.; Johnston, J.; Jones, A.; Matthews, J.; Schaum's Outline of Biochemistry, McGraw-Hill Book Co., 2009, 3rd Edition.

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SEMESTER VI

Course/ Paper Title	**Polymer Chemistry (Major Elective)**
Course Code	**23SBCH67MEA**
Semester	**VI**
No. of Credits	**2 Credits (30 Hours)**

Content

Unit No.	Chapters with contents	No. of lectures
I	**Introductory Concepts**	**04**
II	**Measurement of molecular weight**	**10**
III	**Polymer Reactions**	**04**
IV	**Industrial and Natural Polymers**	**12**

Aims & Objectives of the Course

Sr. No.	Objective
1	The primary objectives of this course are to develop the skills to understand the theory and practice of bio analytical techniques.
2	To provide scientific understanding of analytical techniques and detail interpretation of results.
3	Expanding the understanding of the role, importance and application areas of bioanalytical chemistry.
4	Broadening the knowledge base about the specificities of sampling and preparing biological samples, as well as about methods of bioanalytical chemical investigations

Expected Course Specific Learning Outcomes

Sr. No.	Learning Outcome
1	**Unit I:** After Studying this unit student will able to: - 1. Explain history of polymers. 2. Name different polymers and explain various ways of nomenclature. 3. Differentiate between natural, synthetic, organic and inorganic polymers. 4. Describe uses & properties of polymers.
2	**Unit II:** After studying this unit student will able to: - 1. Term Monomer, Polymer, Polymerization, Degree of polymerization, Functionality, Number average, Weight average molecular weight.

	2. Describe different techniques to measure the average molecular weight of polymers. 3. Analyse different polymers.
3	**Unit III:** After studying this unit student will able to: - 1. Describe different reactions of polymers. 2. Explain different reactions based on various functional groups. 3. Describe role of different reagents on polymers.
4	**Unit IV:** After Studying this unit student will able to: - 1. Describe role of polymer industry in the economy. 2. Explain the advantages of polymers. 3. Describe synthetic methods for natural and industrial polymers.

Syllabus

Unit No	Name of the Topic	Lectures
I	**Introductory Concepts:** Basic Definitions of Polymer, Monomer, Molecular Weight and Molar Mass, End Groups, Polymerization and Functionality, Degree of Polymerization, Copolymers, Polymer Nomenclature, Classification of polymers, Thermoplastics and Thermosets, Plastics, Fibers, and Elastomers. Glass transition temperature, factors affecting glass transition temperature. Numerical problems. **Ref. No: 1** Pages 1-30 **Ref. No: 2** Pages 15-71, 136-172	04
II	**Measurement of molecular weight:** Determination of molecular weight of polymers (Mn, Mw) by end group analysis, viscometry, light scattering method, osmotic pressure method and Turbidimetric titrations. Numerical problems. **Ref. No: 1** Pages 159-202 **Ref. No: 2** Pages 86-98 **Ref. No: 3** Pages 186-218	10
III	**Polymer Reactions**: Hydrolysis, Acetolysis, aminolysis, hydrogenation, addition and substitution reactions, reactions of specific groups such as –OH, -COOH, >C=O and other groups. **Ref. No: 2 Pages 292-302**	04
IV	**Industrial and Natural Polymers:** Important industrial polymers. Synthesis and applications of Polypropylene, Polyacrylonitrile, Polyurethanes, Polyvinyl acetals, Polyvinyl carbazole, Polyvinyl chloride, Polytetrafluoro ethylene, polyamide, polyester, Phenolformaldehyde, epoxide resin, Natural rubber and synthetic rubber (Buna-N, Buna-S and neoprene), cellulose and its derivatives. **Ref. No: 2- Pages 217, 220, 221, 227, 236, 239, 242, 244, 248, 253** **Ref. No. 5- Pages 1-1 to 1-159**	12

References:

1. Introduction to Polymer Science and Chemistry: A Problem-Solving Approach 2nd Edition by Manas Chanda, CRC Press, Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742.
2. Polymer Science by Vasant R. Gowariker, N. V. Viswanathan and Jayadev Sreedhar, New Age International Publishers, New Delhi – 110002.
3. Textbook of Polymer Science, 3rd Edition by Fred Wallace Billmeyer Jr., Wiley-Interscience, New York.
4. Polymer Chemistry: A Practical Approach (The Practical Approach in Chemistry Series) 1st Edition by Fred J. Davis, Oxford University Press Inc., New York.
5. Industrial Polymers, Specialty Polymers, and Their Applications by Manas Chanda and Salil K. Roy, CRC Press, Taylor & Francis Group 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742.
6. Principles of polymer systems 6th Edition by Ferdinand Rodriguez, Claude Cohen, Christopher K. Ober and Lynden A. Archer, CRC Press Taylor & Francis Group 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL 33487-2742

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SEMESTER-VI

Course/ Paper Title	**Analytical Chemistry-II (Major Elective)**
Course Code	**23SBCH67MEB**
Semester	**VI**
No. of Credits	**2 (30 Hours)**

Content

Unit No.	Chapter Title	No. of Lectures
I	**Solvent Extraction**	**07**
II	**Instrumental Methods of Chromatographic Analysis**	**03**
III	**High Performance Liquid Chromatography**	**05**
IV	**Gas Chromatography:**	**05**
V	**Atomic Absorption spectroscopy**	**06**
VI	**Flame Emission Spectroscopy**	**04**

Aims & Objectives of the Course: The student should learn:

Sr. No.	Objectives
1	To learn the separation by using solvent extraction.
2	To understand the atomic spectroscopic methods.
3	To study instrumental technique for analysis of sample.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit I** Define basic terms in solvent extraction. aqueous and organic phase, distribution ratio and coefficient, solute remain unextracted, percent extraction, ion association complex. Explain different principles involved in the analyses using solvent extraction, Perform quantitative calculations depending upon equations student has studied in the theory. Solve / discuss the problem bas.

2	**Unit II** After Studying **Instrumental Methods of Chromatographic Analysis** student will be able to learn: - Define / explain term theoretical plate, HETP, retention time, selectivity, resolution, stationary phase, normal and reverse phase, ion exchange, column efficiency, carrier gas, split and spitless injection, packed column, tubular column, Solve /discuss the problem based on the basis of theory
3	**Unit III** After studying the student will able to learn: - Explain / define different terms in. HPLC etc. Explain principles involved in HPLC. Wavelength selection in HPLC with spectrophotometric and fluorometric detector, Solve / discuss the problem based on Gas chromatography.
4.	**Unit IV** After studying the student will able to learn. Define/Explain Gas chromatography GLC Explain the principle of gas chromatography. To learn equipment of HPLC. Quantitative analysis of GC**.** Solve the numerical based on GC.
5.	**Unit V** After studying Atomic Absorption Spectroscopy the student will able to learn :- Define/Explain, atomic absorption, nebulization, atomization, To know the principle of AAS. To learn the reduction of metal ions in flame, absorbance by atoms in flame, flame atomizers, furnace atomizers, interference in AAS. To understand application of AAS.
	Unit VI After studying Flame Emission Spectroscopy the student will able to learn:- Define/Explain, Flame Emission Spectroscopy, nebulization, atomization. To know the principle of FES. To learn the instrumentation of FES. To understand application of FES.

Syllabus

Unit No.	Title with Contents	No. of Lectures
I	**Solvent Extraction:** Introduction to solvent extraction, organic phase, Partition the theory of extraction (distribution coefficient, Distribution ratio, solute remaining unextracted, Separation coefficient), Factors favoring solvent extraction, Quantitative treatment to solvent extraction equilibrium, Ion association complexes, synergic extraction, some extraction reagent specifically used for inorganic ions (Acetylacetone, 8-Hydroxyquinoline, Diphenylthiocar-bazone, dithiocarbamate), some practical aspects, Applications: determination of copper as the diethyldithiocarbamate complex, Determination of Fe(III) with 8-hydroxyquinoline, determination of nickel by synergistic extraction. Solid phase extraction (Ref-3) **Ref No. 2 Page No.: 242- 253** **Ref No. 3 Page No.: 579- 593**	**07**

II	**Instrumental Methods of Chromatographic Analysis** Principles of Chromatographic Separations, classification, Theory of Column Efficiency in Chromatography, (theoretical plate, rate theory of chromatography - the Van Deemter equation,efficiency and particle size in HPLC, retention factor efficiency and resolution **Supplementary Ref No. 3 Page No.: 547-556** **Ref No. 4 Page No.: 603-617**	**03**
III	**High Performance Liquid Chromatography** Introduction, Types of liquid chromatography (liquid-solid, liquid- liquid, bonded phases), Choice of mode of separation, Equipment for HPLC: mobile phase, sample injection and column design (mobile phase, optimization of mobile phase, gradient elution, solvent delivery and sample injection, sample injection system, the column (effect of column length and column diameter), Choosing the Detector, Ultraviolet detector, Luminescence detector, RI detector, electrochemical detector, Column efficiency, HPLC chromatogram and its characteristics(retention time, peak height, peak area), method of quantitative analysis by HPLC, Example: determination of aspirin, phenacetin and caffeine in a mixture, numerical **Ref No. 2 Page No.: 289-315** **Ref No. 3 Page No.: 649-724** **Ref No. 6 Page No.: 1-325(relevant part)**	**05**
IV	**Gas Chromatography:** Introduction, Apparatus: A supply of carrier gas from a high-pressure cylinder, Sample injection system and derivatization, the column (Packed columns, Open tubular columns), the detector (properties, hot wire detector or TCD, FID, ECD), Quantitative analysis by GC (Area normalization method and internal standard addition method), Elemental analysis, numerical **Ref No. 2 Page No.: 317-337** **Ref No. 7 Page No.: 1-209**	**05**
V	**Atomic Absorption spectroscopy** Introduction, Elementary theory, Instrumentation, flames, the nebulizer-burner system, non- flame techniques, (graphite furnace, cold vapour technique), resonance line sources, monochromator, detectors, interferences, chemical interferences, background correction methods, Atomic absorption spectrophotometers. Experimental preliminaries (calibration curve methods, standard addition method) Preparation of sample (wet ashing, fusion, Dry ashing, microwave dissolution, concentration procedures), Detection limits, Estimation of Ca and Mg in water. **Ref No. 2 Page No.: 612 – 643** **Ref No. 3 Page No.: 556-569** **Ref No. 4 Page No.: 230-247**	**06**
VI	**Flame Emission Spectroscopy** Introduction, emission spectra, flame emission spectroscopy, flame photometers. Evaluation methods, calibration curve procedure, the standard addition technique, Applications: determination of alkali metals by flame photometry, determination of trace elements in contaminated soil by AAS. Numerical,	**04**

	Ref No. 2 Page No.: 645-649, 655-656 **Ref No. 3 Page No.: 553- 556**	

References:

1. Vogel's textbook of Inorganic Quantitative Analysis, Jeffery, Basset, Mendham Deney, 5th Ed, Longman Scientific Technical, USA (copublished with John Wiley Sons)
2. Vogel's textbook of Inorganic Quantitative Analysis, Mendham, Deney Barnes, 6th Ed, Pearson education
3. Analytical Chemistry by G. D. Christian, et al , Wiley, 6th Ed.
4. Principles of Instrumental Analysis: Holler, Skoog, Crouch 6th Ed. Thomson Publication
5. Modern Analytical Chemistry, David Harvey, Mc-Graw Hill Higher education
6. High performance Liquid Chromatography, (Analytical Chemistry through open learning series) Second Ed, Sandie Lindsay, Wiley
7. Gas Chromatography, (Analytical Chemistry through open learning series) 2nd Ed, Ian A. Fowlis, Wiley

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SEMESTER-VI

Course/ Paper Title	**Internship (On-the-Job Training, OJT)**
Course Code	**23SBCH6OJT**
Semester	**VI**
No. of Credits	**4 (120 Hours)**

Content

Module No.	Title of Module	No. of Hours
I	**Introduction to Environment of Corporate Office / Industry / Research Laboratory/ Education and Training / Scientific Writing/Any other relevant field**	**10**
II	**Practical Training**	**80**
III	**Soft Skills and Professional Development**	**10**
IV	**Project Work and Case Studies**	**20**

Aims & Objectives of the Course: The student should/d learn:

Sr. No.	Objectives
1	To provide hands-on experience and practical exposure to chemical industries, research environments, Education and Training.
2	To bridge the gap between theoretical knowledge and requirements of work environment.
3	To develop essential soft-skills like verbal and written communication, computer knowledge, team work, professional approach, maintenance of record, analysis of data and presentation of reports

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Module I:** After completing Module I, students will be able to: 1. Familiarize themselves with the structure, functions, and safety protocols of workplace.

	2. Demonstrate a clear understanding of ethical practices, workplace etiquette, and compliance requirements in workplace settings. 3. Recognize the roles and contributions of the chemical sciences to industrial operations and research environments.
2	**Module II:** After completing Module II, following outcomes are expected 1. Skill Development: Students will gain practical skills and knowledge relevant to the industry or role and they will learn to use tools, technologies, or software specific to the job. 2. Workplace Familiarity: Students will be able to understand workplace norms, professional etiquette, and organizational culture and learn to adapt to the operational workflow and collaborative dynamics. 3. Problem-Solving and Critical Thinking: The OJT is expected to help students in developing the ability to analyse situations, propose solutions, and make informed decisions and handling challenges effectively in a real-world setting. 4. Role-Specific Competencies: As per the sector they will acquire hands-on experience in performing tasks and responsibilities aligned with the role. 5. Communication and Teamwork: Working in actual settings will help the students to understand interpersonal dynamics at workplace with superiors, colleagues and subordinates and it will also enhance professional communication skills. 6. Time Management and Accountability: OJT is expected to bring awareness about punctuality, responsibility, time management, accountability and other virtues desired in a good professional individual. 7. Professional Growth: OJT is expected to build confidence in applying theoretical knowledge to practical situations. Make them learn new skills and improve the overall personality, which shall be useful in making future career decisions. By achieving these outcomes, the student may develop a well-rounded understanding of their chosen field, bridging the gap between academic learning and practical application.
3	**Module III:** After completing Module III, students will be able to: 1. Collaborate effectively within a team in work environment, contributing to collective goals. 2. Manage time efficiently by prioritizing tasks and adhering to deadlines. 3. Communicate effectively through written reports, oral presentations, and interpersonal interactions.
4	**Module IV:** After completing Module IV, students will be able to: 1. Design and execute a small-scale project under the supervision of place of OJT. 2. Compile a comprehensive project report detailing the objectives, methods, findings, and implications of the work. 3. Present project outcomes in a professional setting and demonstrate in-depth understanding during a viva voce.

Syllabus or Broad Outline

Module No.	Title with Contents	No. of Hours
I	**Introduction to Industry/Research Environment:** 1. Orientation Program: Overview of the company/organization, Safety protocols and compliance, Code of conduct in laboratories/industries. 2. Understanding roles and functions of the industry in chemical sciences.	**10**
II	**Practical Training:** 1. **Understanding Work Dynamics:** Understand the nature of work and responsibilities of the work environment and skills required for the role to be played. 2. **Developing Skills:** Learn the skill sets needed, work as an active team member. 3. **Task Management and Execution:** Gain insights of the background, vision, products/services and trends. Familiarize with the role and tasks assigned during the OJT. Complete the assigned tasks and report regularly to the supervisor. 4. **Documentation and Reporting:** Keeping records of the work on a daily basis with geotagged photographs, description of work completed in a log book signed by training supervisor with date.	**80**
III	**Soft Skills and Professional Development:** 1. Teamwork and collaboration in an industrial/research setting. 2. Time management and task prioritization. 3. Computer Applications like MS Office. 4. Communication skills: Reporting findings and presenting results.	**10**
IV	**Project Work and Case Studies (20 Hours)** 1. Undertake a small project under the guidance of an industry/research supervisor. 2. Perform data analysis and interpret results. 3. Add photographs of workplace and record videos to be submitted with the report. 4. Prepare and submit a detailed project report along with the certificate of completion of the OJT. 5. Appear for viva voce and explain the OJT in detail.	**20**

Internship Domains: Students may undertake internships in the following fields:

1. Pharmaceutical Industries
2. Chemical Manufacturing Industries
3. Environmental Analysis Laboratories
4. Water Treatment Plant
5. Food and Dairy Industries
6. Research and Development (R&D) Institutions
7. Forensic Science Laboratories
8. Education and Training Sector
9. Scientific Writing

After completing the internship, students will submit the following documents:

1. Internship Completion Certificate from the Industry/Research Organization.
2. Logbook and Project Report.

Assessment Pattern of Internship (OJT):

Item	Assessment criteria	Percentage weightage
Daily Logbook	Students will maintain a logbook documenting their daily activities and learning	10%
Performance Evaluation	Feedback from the internship supervisor based on punctuality, participation and skill acquisition.	50%
Project Report	Submission of a detailed project report, including an introduction, methodology, geotagged photographs showing date and location, results, and conclusion.	20%
Presentation/Viva	Oral presentation of the project work and viva voce	20%

Important Guidelines for College:

1. Collaborate with industries, research institutes and organizations to arrange internships.
2. Assign faculty coordinators to monitor and guide students during the internship.
3. Ensure students adhere to safety protocols and ethical practices.

Dr. Khursheed Ahmed
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