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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

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 [CBCS]

Semester	Course code	Title of course	No. of Credits and Lectures	DSEC/SEC
V	21SBCH351	Physical Chemistry-I	2, 36 Lectures	DSEC
	21SBCH352	Analytical Chemistry-I	2, 36 Lectures	DSEC
	21SBCH353	Physical Chemistry Practical-I	2, 48 Lectures	DSEC
	21SBCH354	Inorganic Chemistry-I	2, 36 Lectures	DSEC
	21SBCH355	Industrial Chemistry	2, 36 Lectures	DSEC
	21SBCH356	Inorganic Chemistry Practical-I	2, 48 Lectures	DSEC
	21SBCH357	Organic Chemistry-I	2, 36 Lectures	DSEC
	21SBCH358	Chemistry of Biomolecules	2, 36 Lectures	DSEC
	21SBCH359	Organic Chemistry Practical-I	2, 48 Lectures	DSEC
	21SBCH3510A or 21SBCH3510B	Introduction of Medicinal Chemistry (A) or Polymer Chemistry (B)	2, 36 Lectures	SEC
	21SBCH3511A or 21SBCH3511B	Environmental Chemistry (A) or Special Topics of Competitive Chemistry-I (B)	2, 36 Lectures	SEC
VI	21SBCH361	Physical Chemistry-II	2, 36 Lectures	DSEC
	21SBCH362	Physical Chemistry -III	2, 36 Lectures	DSEC
	21SBCH363	Physical Chemistry Practical-II	2, 48 Lectures	DSEC
	21SBCH364	Inorganic Chemistry-II	2, 36 Lectures	DSEC
	21SBCH365	Inorganic Chemistry-III	2, 36 Lectures	DSEC
	21SBCH366	Inorganic Chemistry Practical-II	2, 48 Lectures	DSEC
	21SBCH367	Organic Chemistry-II	2, 36 Lectures	DSEC
	21SBCH368	Organic Chemistry-III	2, 36 Lectures	DSEC
	21SBCH369	Organic Chemistry Practical-II	2, 48 Lectures	DSEC
	21SBCH3610A or 21SBCH3610B	Chemistry of Soil and Agrochemicals (A) or Techniques in Bioanalytical Chemistry (B)	2, 36 Lectures	SEC
	21SBCH3611A or 21SBCH3611B	Analytical Chemistry-II (A) or Special Topics of Competitive Chemistry-II (B)	2, 36 Lectures	SEC

Important points:

i. Each credit is equivalent to 18 lectures of 50 minutes for theory courses and 24 lecture of 50 minutes for practical courses.
ii. There will be12 practical sessions per semester of 3 hours 15 minutes each.
iii. 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).
iv. For more details refer to UG rules and regulations (CBCS for Science program under Science & Technology) on SPPU website.

Evaluation Pattern (As per CBCS rules)

1. Each theory and practical course carry 50 marks equivalent to 2 credits.

2. Each course will be evaluated with Continuous Internal Assessment (CIA) 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 has to 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 CBCS - 2021 Pattern) 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 Choice Based Credit System (CBCS: 2021 pattern) and to be implemented form academic year 2023-24. In CBCS pattern semester system has been adopted for B. Sc. degree programme. Different types of courses are introduced at degree level viz. Discipline Specific Core Course (DSCC), Ability Enhancement Compulsory Course (AECC), Discipline Specific Elective Course (DSEC) and Skill Enhancement Course (SEC). DSCC courses has been introduced at FY/SY level and AECC courses at SY level. At TY level DSEC and SEC courses are to be introduced. Third year syllabus comprises of six theory and three practical courses of DSEC type and two theory SEC per semester.

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Choice Based Credit System [CBCS]

From Academic Year 2023-24

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

Board of Studies (Chemistry)

Post Graduate Department of Chemistry and Research Center, Abeda Inamdar Senior College of Arts, Science and Commerce, Pune-411001

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SEMESTER-V

Course/ Paper Title	**Physical Chemistry-I**
Course Code	**21SBCH351**
Semester	**V**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Content

Unit No.	Title of Unit	No. of lecture
I	**Photochemistry**	**10**
II	**Investigation of Molecular Structure**	**16**
III	**Quantum Chemistry**	**10**

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 Lectures
1.	**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,	**10**

	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.	
2.	**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.	**16**
3.	**Quantum Chemistry:** Introduction, de-Broglie hypothesis, The Heisenberg's uncertainty principle, quantisation of energy, Operators,	**10**

	Schrodinger wave equation, well behaved function, Particle in a one-, two and three-dimensional box (no derivation), Physical interpretation of the ψ and $\psi 2$, 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:

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

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SEMESTER-V

Course/ Paper Title	**Analytical Chemistry-II**
Course Code	**21SBCH352**
Semester	**V**
No. of Credits	**(2, (36 Lectures of 50 Minutes)**

Content

Unit No.	Title of Unit	No. of lecture
I	**Gravimetry**	**09**
II	**Thermal methods of Analysis**	**07**
III	**Nephelometry and Turbidimetry**	**06**
IV	**Parameters of Instrumental Analysis**	**05**
V	**UV-Visible Spectroscopy**	**09**

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 the 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. To learn reagent for analysis, reaction condition to convert analyte into measurable form, drying and ignition temperature for ppt in gravimetry. 4. 4. Perform quantitative calculations depending upon equations student has studied in the theory. 5. Solve / discuss the problem based on solubility product.
2	**Unit II:** After Studying surface 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 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 able to learn. 1. Define/Explain Linearity range, detection limit, precision, accuracy, Sensitivity, Selectivity, Robustness and Ruggedness 2. To 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 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, 485 **Ref. 2:** Page No. 342 - 362	**09**
II	**Thermal methods of Analysis:** General discussion, Thermogravimetry, Experimental factors affecting TG analysis, Instruments for thermogravimetry, Applications: Thermogravimetric analysis of CaC2O4 H2O, CuSO4 5H2O, Differential Thermal Analysis: Introduction, instrumentation for DTA and DSC, experimental and instrumental factors, applications: DTA of	**07**

	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	**06**
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	**05**
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, simultaneous analysis, Applications: spectrophotometric titration (example Cu(II) with EDTA), Determination of pKa value of indicator, Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. Numerical **Ref. 1-** Page No. 645-725 **Ref. 2-** Page No. 658-717	**9**

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	**Physical Chemistry Practical-I**
Course Code	**21SBCH353**
Semester	**V**
No. of Credits	**2 (48 Lectures of 50 Minutes)**

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	1

	method.	
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 calorimetrically	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	**Inorganic Chemistry-I**
Course Code	**21SBCH354**
Semester	**V**
No. of Credits	**02 (36 Lectures of 50 Minutes each)**

Content

Unit No.	Title of Unit	No. of lecture
I	**Molecular Orbital Theory of Coordination Compounds**	**08**
II	**Chemistry of transition elements**	**06**
III	**Chemistry of f-block elements**	**08**
IV	**Acid–Base and Donor–Acceptor Chemistry**	**08**
V	**Chemical Toxicology**	**06**

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	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
3	The ability to write electronic configuration of lanthanides and actinides and oxidation states of lanthanides and actinides and common oxidation states.
4	Student will learn the concept of acid base and their theories and they will also come to know different properties of acids and bases.
5	To know toxic chemical in the environment and impact of toxic chemicals on enzyme.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit I:** 1. Explain electroneutrality 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. To know position of d-block elements in periodic table. 2. To know the general electronic configuration & 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.
3	**Unit III:** 1. The meaning of term f-block elements, Inner transition elements, lanthanides, actinides. 2. Electronic configuration of lanthanides and actinides. Oxidation states of lanthanides and actinides and common oxidation states. 3. Separation lanthanides by modern methods. Lanthanide contraction and effects of lanthanide contraction on post-lanthanides. 4. Use of lanthanide elements in different industries. 5. Transuranic elements. Preparation methods of transuranic elements. 6. Nuclear fuels and their applications. Why transuranic elements are called as the synthetic elements? 7. IUPAC nomenclature for super heavy elements with atomic no. 100 onwards.
4	**Unit IV:** 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.
5	**Unit V:** 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.

Syllabus

Unit No.	Title With Content	No. of Lectures
1	**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-** Page No. 226-231. **Ref: 2-** Page No. 95-120**.**	**08**

2	**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: 3 Page No.651-677**	**06**
3	**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: 3- Page No. 874-875, 879-886, 891-893, 898-900**	**08**
4	**Acid–Base and Donor–Acceptor Chemistry:** Acid–Base Models as Organizing Concepts, Arrhenius Concept, Brønsted–Lowry Concept, solvent system concept, Lux Flood concept, Lewis Concept, Frontier Orbitals and Acid–Base Reactions, Hard and soft acids and bases, theory of hard and soft acids bases, Acid and base strength (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 and acid and base strengths, super acids). **Ref: 4 Page No. 67-178, 183-208**	**08**
5	**Chemical Toxicology:** Toxic chemicals in the environment, Impact of toxic chemistry on enzymes. Biochemical effect of Arsenic, Cadmium, Lead and Mercury. Biological methylation. **Ref: 5- Page No. 75-100**	**06**

Reference Books:

1. Concise Inorganic Chemistry by J.D. Lee - 4th Edition
2. Physical Inorganic Chemistry A Coordination Chemistry Approach S. F. A. Kettle Springer-Verlag Berlin Heidelberg GmbH, 1996
3. Concise Inorganic Chemistry by J.D. Lee - 5th edition
4. Inorganic chemistry, Gary L Messler and Donald A Tar, Third Ed, Pearson Publisher
5. Environmental chemistry by A.K.De Publisher- Wiley Eastern Limited New Age International Limited.

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SEMESTER-V

Course/ Paper Title	**Industrial Chemistry**
Course Code	**21SBCH355**
Semester	**V**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Content

Unit No.	Title of chapter	No. of lecture
I	Modern Approach to Chemical Industry	06
II	Manufacture of Basic Chemicals	07
III	Sugar and Fermentation Industry	07
IV	Soap and Detergents Industry	08
V	Dyes and Pigments	08

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

Sr. No.	Objectives
1	Importance of chemical industry, Knowledge of various industrial aspects.
2	Concept of basic chemicals, their uses and manufacturing process and also know the physico-chemical principals involved in manufacturing process
3	Importance of sugar industry, fermentation industries and their Basic requirement and process
4	Different types of soap products, Raw materials for detergents, Detergent builders, additives and manufacture process
5	Students should know about Dyes, Dye intermediates, Synthesis, Structures, properties and applications of dyes, pigments

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	After studying the industrial chemistry, students will able to define the chemical industries, Importance and types of various industrial aspects.

2	Students should be able to understand the concept of basic chemicals, their uses and manufacturing process and also understand the physico-chemical principals involved in manufacturing process
3	Students should be able to understand the Importance of sugar industry, fermentation industries and their Basic requirement and process
4	Students should be able to understand the Different types of soap products, Raw materials for detergents, Detergent builders, additives and manufacture process
5	Students should be able to define the Dyes, Dye intermediates, Synthesis, Structures, properties and applications of dyes, pigments

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:** Pages 5-15 **Ref. 4:** Pages 10-55	**06**
II	**Manufacture of Basic Chemicals** a) **Ammonia:** Manufacture of ammonia by modified Haber-Bosch process, Physico-chemical principles involved and uses of ammonia. b**) Nitric acid:** Manufacture of nitric acid by Ostwald's process, Physico-chemical principles involved and uses of nitric acid. c) **Sulphuric acid:** Manufacture of sulphuric acid by contact process, Physico-chemical principles involved and uses of sulphuric acid. **Ref. 2:** Pages 731 to 761, 809 to 844, **Ref. 3:** Pages 1128-1175, 1253-1263	**07**
III	**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, **Ref. 2:** Pages 1208-1218 **b) Fermentation Industry**: Introduction, importance, conditions favorable 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.	**07**

	Ref. 2: Pages 1176-1184	
IV	**Soap and detergents** **a) Soap:** Soap and Fatty Acids: Introduction, Chemistry, Manufacturing Technology, Raw Materials, Functional Properties of Soap, Manufacturing Processes, Saponification Reactor, Cooling, Soap Separator, Soap Extraction, Centrifugation, Neutralization, Direct Neutralization, Carbonate Neutralization, Partial Neutralizing with Soda Ash, Carbon Dioxide Separation, Raw Material Dosing, Caustic Soda, Completion of Neutralizing with Caustic Soda, Neutralization Soap Viscosity, **Ref. 2:** Pages 1243 -1250 **Ref. 4:** Pages 980-997, **b) Detergents:** Synthetic Detergents: Introduction, Characteristic Features of Surfactants, Raw Materials for Surfactant Production, intermediates for Surfactant Production, Anionic Surfactants, Non-ionic Surfactants, Amphoteric Surfactants, Cationic Surfactants, Detergent Additives, Production of Synthetic Detergents, and Washing action of soap and detergents. **Ref. 2:** Pages 252-1279 **Ref. 4:** Pages 1006-1029,	**08**
V	**Dyes and Pigments** **a) Dyes:** Introduction, qualities of good dye, Colour constituents (Chromophore, auxochrome), classification of dyes according to their application, Synthesis and uses of following dyes: Nitroso dye-martius yellow, Azo dyes-Methyl orange and aniline yellow, Triphenylmethane dye-Crystal violet, Phthalein dye - Phenolphthalein, Xanthane-Fluorescein, Antha-quinnoeAlizarin and Indigo dyes - Indigo. **Ref. 2:** Pages 1545-1595 **b) Pigments:** Introduction, classification and general properties of pigments. Inorganic pigments: i) Zinc oxide pigments (Fundamentals and properties, Raw materials, Direct process (American process), Precipitation process) ii) Iron oxide pigments (Fundamentals and properties, Production of iron oxide pigment by precipitation process). **Ref. 5:** Pages 80-87, 97 to 109.	**08**

References:

1. Shreeve's chemical process industries 5th Edition, G.T. Austin, TATA McGraw-Hill Edition, chemical engineering series
2. Industrial Chemistry, B. K. Sharma, Goel publishing House, 18th Ed. (2014)
3. Advanced Inorganic Chemistry, Satyaprakash, Tuli, Basu

4. Handbook of Industrial Chemistry and Biotechnology, James A. Kent, Tilak V. Bommaraju, Scott D. Barnicki, Thirteenth Edition, Springer
5. Inorganic Pigments by Gerhard Pfaff, Publisher-De Gruyter, 1st Ed

Additional Reference:

1. Intellectual Property-The Law of Trademarks, Copyrights, Patents, and Trade Secrets, Deborah E. Bouchoux, Fourth edition, Delmar, Cengage Learning

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SEMESTER-V

Course/ Paper Title	**Inorganic Chemistry Practical-I**
Course Code	**21SBCH356**
Semester	**V**
No. of Credits	**02 (48 Lectures of 50 Minutes)**

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.

Syllabus

Sr. No.	Title with Contents	Practical Sessions
A. Gravimetric Estimations (Any Five)		
1.	Gravimetric estimation of Fe as Fe_2O_3	1
2.	Gravimetric estimation of Ba as $BaSO_4$ using homogeneous precipitation method	1
3.	Gravimetric estimation of Nickel as Ni-DMG	1
4.	Analysis of sodium bicarbonate from mixture by thermal decomposition method	1
5.	Determination of water of crystallization by thermal decomposition	1
6.	Analysis of Food/Pharmaceutical sample for ash and sulphated ash example-Aspirin	1
7	Band gap calculation for the nanomaterial TiO_2/ SnO_2/ ZnO from its electronic spectra using UV-Visible Spectroscopy	1
B. Inorganic preparations (Any Five)		
1.	Synthesis and purity of hexamminenickel (II) chloride	1
2	Synthesis and purity of Potassium trioxalatoferrate (III)	1
3	Synthesis and purity of Manganese (III) acetylacetonate	1
4	Synthesis and purity of Tris (glycinato)nickelate (II)	1
5	Synthesis and purity of Potassium dioxalatocuprate (II)	1
6	Synthesis of Silver nanoparticles and to find the band gape spectrophotometrically	1
7	Synthesis of ZnO nanoparticles	1
C. Inorganic Qualitative Analysis (Any Two)		
1	Limit test for iron, chloride and sulphate from pharmaceutical raw materials.	1
2	Qualitative and confirmatory tests of inorganic toxicants of any four ions (Borate, copper, hypochlorite or nitrate or nitrite, Sb or Bi, Iodate, H_2O_2).	1
3	To determine composition of copper sulphate pentahydrate ($CuSO_4.5H_2O$) by using Thermo Gravimetric Analysis (TGA)	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
11. A laboratory course in nanoscience and nanotechnology, Dr. Gerrad Eddy Jai Poinem, CRC press.

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SEMESTER-V

Course/ Paper Title	**Organic Chemistry-I**
Course Code	**21SBCH357**
Semester	**V**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Content

Unit No.	Title of chapter	No. of lecture
I	**Polynuclear and Heteronuclear Aromatic Compounds**	**8**
II	**Active Methylene Compounds**	**5**
III	**Rearrangement Reactions**	**12**
IV	**Elimination reactions**	**11**

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

Sr. No.	Objectives
1	To develop understanding of reactivity of heterocyclic compounds.
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.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit I: Polynuclear and Heteronuclear Aromatic Compounds** After studying the polynuclear and heteronuclear aromatic compounds, students will able to 1. Define and classify polynuclear and hetreonuclear aromatic hydrocarbons. 2. Write the structure, synthesis of polynuclear and hetreonuclear aromatic hydrocarbons. 3. Understand the reactions and mechanisms 4. Explain the reactivity of polynuclear and hetreonuclear aromatic hydrocarbons.

	5. Describe the synthesis of chemical reactions of polynuclear and hetreonuclear aromatic Hydrocarbons.
2	**Unit II: Active Methylene Compounds:** Students should be able to understand 1. Meaning of active methylene group 2. Reactivity of methylene group 3. Synthetic applications ethyl acetoacetate and malonic ester 4. To predict product with panning or supply the reagent/s for these reactions
3	**Unit III: Molecular Rearrangements** Students will study 1. What is rearrangement reaction? 2. Different types of intermediate in rearrangement reactions 3. To write the mechanism of some named rearrangement reactions and their applications 4. Electrocyclic rearrangement with their mechanisms Chapter
4	**Unit IV: Elimination Reactions** Students will study 1. 1,1 and 1,2 elimination 2. E1, E2 and E1cB mechanism with evidences of these reactions 3. Understand stereochemistry by using models and learn reactivity of geometrical isomers 4. Orientation and reactivity in E1 and E2 elimination 5. Hoffmann and Saytzeff's Orientation 6. Effect of factors on the rate elimination reactions

Syllabus

Unit No.	Title with Contents	No. of Lectures
I	**Polynuclear and Heteronuclear Aromatic Compounds** Introduction, Classification of aromatic compounds, Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene, Furan, Pyrrole, Thiophene, and Pyridine. **Ref. 1:** Pages 759 – 779 **Ref. 2:** Pages 952 – 962	**08**
II	**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	**05**

	Ref. 2: Pages 859 – 874 **Ref. 4:** Pages 206 – 213	
III	**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. Electrocyclic Rearrangements- Claisen, Cope and Mc-Lafferty rearrangements with mechanism. **Ref. 3:** Pages 618-656. **Ref. 5:** Pages 89-94, 105-107, 112-114, 122-125, 158-161 **Ref. 8:** Pages 130-132	**12**
IV	**Elimination Reactions** Introduction; Types of eliminations-1,1; 1,2 elimination, Mechanism with evidences of E1and E2, E1cB reactions, stereochemistry of E1 and 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	**11**

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. Eliel: Stereochemistry of Organic Compounds, Tata Mc Graw Hill, 1989
7. D. Nasipuri: Stereochemistry of Organic Compounds- Principles and Applications, New Age International Publishers, 3rd Edition.
8. Jagdamba Singh, Jaya Singh: Photochemistry and Pericyclic reactions.3rd 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	**Chemistry of Biomolecules**
Course Code	**21SBCH358**
Semester	**V**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Unit No.	Title of Topic/Chapter	No. of lectures
I	**Introduction Origin, aim and scope of Biochemistry**	**03**
II	**Amino acids and Protein**	**08**
III	**Nucleotides and Nucleic acids**	**07**
IV	**Carbohydrates**	**07**
V	**Lipids**	**07**
VI	**Vitamins**	**04**

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

Sr. No.	Objectives
1	To develop concepts about structures and functions of different biomolecules.
2	To understand the reactivity of biomolecules and their role in metabolic pathways.

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. Define Biochemistry 2. Objectives of biochemistry 3. Scope and Importance of biochemistry 4. Fields of biochemistry 5. Milestones in history of biochemistry. 6. The properties of water with its role in physiology of biological systems
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 side-chains (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 side-chains (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 Lectures
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.	**03**

	Ref 1- Page 1, 47-74 **Ref 2- Pages 2-4, 23-36** **Ref 4- Page 1**	
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**	**08**
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**	**07**
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**	**07**
V	**Lipids:** Classification, structure and function of major lipid subclasses- Triacylglycerols, Phospholipids, Sphingolipids, glycolipids, Lipoproteins, chylomicrons, LDL, HDL and VLDL, steroids, 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**	**07**
VI	**Vitamins:** Structure and Classification, water soluble and fat-soluble vitamins. **Ref 1- Page 42**	**04**

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 V

Course/ Paper Title	**Organic Chemistry Practical-I**
Course Code	**21SBCH359**
Semester	**V**
No. of Credits	**2 (73 Lectures of 50 Minutes)**

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
1.	**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 must be insoluble in water)	
	a) Solid-Solid (3 Mixtures)	3

	b) Solid-Liquid (2 Mixtures)	2
	c) Liquid-Liquid (1 Mixture)	1
2.	**B) Preparations**	
	a) Green Chemistry Preparations (Any Two)	2
	1. Preparation of dibenzalpropanone from benzaldehyde and acetone using $LiOH.H_2O$/NaOH	
	2. Nitration of phenol or substituted phenols using $CaNO_3$	
	3. Bromination of acetamide using ferric ammonium nitrate and KBr in aqueous medium.	
	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	**Introduction to Medicinal Chemistry**
Course Code	**21SBCH3510A**
Semester	**V**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Content

Unit I	An Introduction to Drugs, their Action and Immunobiologicals
Unit II	Bio-physicochemical Properties in Drug Action and Design
Unit III	Drugs for Infectious Diseases
Unit IV	Drugs for Non -infectious Diseases

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.
5	Enhancement of practical skills in synthesis, purification and analysis

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	**08**
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	**08**
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,	**12**

	Ref. 2: Pages 413-472, Ref. 3: Pages 258-308, Ref. 4: Pages 191-228 Ref. 6: Online Ref. 7: Online	
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	**08**

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 SARS-CoV-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	**Polymer Chemistry**
Course Code	**21SBCH3510B**
Semester	**V**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Contents

Unit No.	Title of Topic/Chapter	No. of lecture
I	**Introductory Concepts**	**06**
II	**Measurement of molecular weight**	**06**
III	**Polymerization Processes**	**08**
IV	**Industrial and Natural Polymers**	**12**
V	**Polymer Reactions:**	**04**

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

Sr. No.	Objectives
1	To understand the importance of the chemical approach to polymers and the subject provides an introduction to polymer science with respect to synthesis, polymerization process by step-growth and chain-growth polymerization.
2	To understand about radical and ionic polymerization and techniques of polymer analysis.
3	To study the methods of measuring the molecular weights, polymerization kinetics, polymer synthesis and reactions.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
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 the mechanisms of polymerization. 2. Describe the different polymerization techniques.
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.
5	**Unit V:** 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.

Syllabus

Unit No.	Title with Contents	No. of 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. **Ref. No: 1** Pages 1-30 **Ref. No: 2** Pages 15-71, 136-172	**06**
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. **Ref. No: 1** Pages 159-202 **Ref. No: 2** Pages 86-98 **Ref. No: 3** Pages 186-218	**06**
III	**Polymerization Processes:** Mechanism of polymerization of Addition polymerization, step polymerization, Chain growth polymerization (free radical and ionic), Zeigler-Natta polymerization. Ref. No: 3 Pages 25-98 Ref. No: 4 Pages 43-90	**08**

	Ref. No: 6 Pages 107-170	
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**
V	**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**

Reference Books:

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

Additional References:

1. Organic Polymer Chemistry: An Introduction To The Organic Chemistry Of Adhesives, Fibres, Paints, Plastics And Rubbers, 2nd Edition, by K. J. Saunders, Chapman and Hall Ltd., 11 New Fetter Lane, London EC4P 4EE.
2. Polymers, Polymer Blends, Polymer Composites And Filled Poymers: Synthesis, Properties And Applications by Abdulakh K. Mikitaev, Mukhamed Kh. Ligidov and Gennady E. Zaikov, Nova Science Publishers, Inc.New York.
3. Synthetic Polymer-Polymer Composites by Debes Bhattacharyya and Stoyko Fakirov, Carl Hanser Verlag, Postfach 86 04 20, 81631 München, Germany.

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SEMESTER-V

Course/ Paper Title	**Environmental Chemistry**
Course Code	**21SBCH3511A**
Semester	**V**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Content

Unit No.	Title of Unit	No. of lecture
I	**Concepts and Scope of Environmental Chemistry**	6
II	**Hydrosphere and Water Pollution**	10
III	**Analytical Techniques in water Analysis**	10
IV	**Water pollution and treatment**	10

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

Unit No.	Objectives
1	1. Importance and conservation of environment. 2. Importance of biogeochemical cycles
II	1. Water resources 2. Hydrological Cycle 3. Organic and inorganic pollutants.
III	1. Parameters of water quality. 2. Methods and Techniques used in water analysis.
IV	1. Types of Water pollution. 2. To remove pollutants from wastewater at their sources.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit 1:** Students should know: 1. Water should be conserved to get ready for future disaster like drought. 2. Importance of biogeochemical cycles as they help how the planet conserves matter and uses energy.
2	**Unit 2:** Students should know: 1. Water cycle is essential for the maintenance of most life and ecosystems on the planet. 2. Types of pollutants and how to treat them.
3.	**Unit III:** Students should understand: The parameters of water quality and analytical methods can detect and measure all the natural elements and their inorganic compounds and organic chemical species.
4.	**Unit IV:** Importance of treatment of water pollution as water pollutants may cause various diseases and pollute environment.

Syllabus

Unit No.	Title with Contents	No. of Lectures
1.	**Concepts and Scope of Environmental Chemistry:** Introduction, Environmental Pollution and Classification, Units of concentration, Segments of Environment, Biogeochemical cycles of C, N, P, S and O system **Ref. No:** 2 Pg No.: 1-2,6-10,16-32 **Ref. No:** 4 Pg No.: 13-14,23-24	**06**
2.	**Hydrosphere and Water Pollution:** Water resources, Hydrological Cycle: stages of hydrological cycle and chemical composition of water bodies, Microbially mediated aquatic reactions, Classification of water pollutants Organic and Inorganic pollutants, Sewage and Domestic waste, Sediments, Detergents, Pesticides, Eutrophication, **Ref. 1:** Pg. No. 47-62 **Ref. 2:** Pg. No.: 219-244, 459-491 **Ref. 4:** 70-77, 133-147, 244, 342-417	**10**
3.	**Analytical Techniques in water Analysis:** Water quality parameters and standards, domestic water quality parameters, surface water, sampling, preservation, Monitoring techniques and methodology (pH, conductance, DO, ammonia, nitrate and nitrite, Cl, F, CN, sulphate, phosphate, total hardness, boron, metals and metalloids- Cd Cr, Cu, Fe, Pb, Hg (Exclude polarographic and AAS methods), COD, BOD, TOC, phenols, pesticides, surfactants,	**10**

	tannins and lignin, E. Coli, Case studies of water pollution **Ref. 2:** Pg No.:453-454, 461-462, 471-474, 477-493 **Ref. 4:** Pg No.: 430-462	
4.	**Water pollution and treatment:** Water pollutants, Eutrophication, Waste water treatment (domestic waste water, aerobic treatment, anaerobic treatment, upflow aerobic sludge bed, industrial waste water treatment, drinking water supplies, Trace elements in water, chemical speciation (Hg, As, Se, Cr) **Ref. 1:** Pg. No. 167-225 **Ref. 2:** Pg. No. 273 **Ref. 4:** Pg No.419-435,451-453,457-453	**10**

Reference Books:

1. Environmental Chemistry – A. K. De, Third Edition (Wiley)
2. Environmental Chemistry – A. K. Bhagi and C. R. Chatwal (Himalaya Publishing House)
3. Environmental Chemistry – H. Kaur 2nd Edition 2007, Pragati Prakashan, Meerut, India
4. Environmental chemistry with Green chemistry – Asim K. Das
5. Environmental Chemistry – J. W. Moore and E. A. Moore (Academic Press, New York)
6. Basic Concepts of Analytical Chemistry: S. M. Khopkar, Wiley Eastern (1995)
7. Environmental Chemistry – A. K. De, 5th Edition (New age international publishers)

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SEMESTER-V

Course/ Paper Title	**Special Topics of Competitive Chemistry-I (B)**
Course Code	**21SBCH3511B**
Semester	**V**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Content

Unit No.	Title of Unit	No. of lecture
I	**Thermodynamics**	**12**
II	**Main Group Elements (s and p blocks):**	**12**
III	**Aromaticity and Stereochemical Predictions**	**12**

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

Sr. No.	Objectives
1	To provide additional knowledge on important topics in Chemistry with respect to competitive examination point of view.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	Students should be able to solve the numerical problems, memory-based questions as well as predict the product on the basis of their understanding of reaction mechanism, knowledge of various reagents and their applications.

Syllabus

Unit No.	Title with Contents	No. of Lectures
I	**Thermodynamics** The First Law of Thermodynamics and internal energy, Expansion work, Enthalpy, The variation of enthalpy with temperature, State functions and exact differentials, Maxwell relations, Changes in internal energy, Changes in internal energy at constant pressure, The Joule–Thomson effect, Problems. **Ref No 1**: Page No. 28-66 **Ref No 2:** Page No. 45-63	**12**
II	**Main Group Elements (s and p blocks)** Reactions of alkali and alkaline earth metals with oxygen, hydrogen and water; Alkali and alkaline earth metals in liquid ammonia; Gradation in properties of main group element in a group; Inert pair effect; Synthesis, structure and properties of diborane, ammonia, silane, phosphine and hydrogen sulphide; Allotropes of carbon; Oxides of nitrogen, phosphorus and sulphur; Oxoacids of phosphorus, sulphur and chlorine; Halides of silicon and phosphorus; Synthesis and properties of borazine, silicone and phosphazene; Synthesis and reactions of xenon fluorides. **Ref No. 3:** Page No. 374-610, **Ref No. 4**: Page No. 293 -446	**12**
III	**Aromaticity and Stereochemical Predictions** Aromaticity: Aromatic compounds, non-Aromatic compounds, Anti aromatic compounds, Rules for Aromaticity, Quasi-aromatic compounds, Aromaticity in higher Annulenes, Homo-aromaticity, Aromaticity in fused rings, applications of aromaticity. **Ref No. 6**, Page No. 55-94 **Stereochemical predictions:** Stereoselectivity and stereospecificity, Topicity: enantiotopic and diasterotopic atoms, groups and faces, RS descriptors in biphenyl rings, Felkin model and Cram's Rule **Ref No. 7**, Page No. 142-154, 213-214, **Ref No. 8**, Page No. 215-219	**12**

References

1) Atkins Physical Chemistry, Eighths Edition.
2) Physical chemistry by Thomas Engel and Phillip Reid, Third Edition
3) Principles of inorganic chemistry by Puri, Sharma and Kalia First Edition.
4) Shriver and Atkins Inorganic Chemistry, Fifth Edition.
5) Inorganic Chemistry by James E. Huheey, Ellen A. Keiter, Richard L. Keiter and Okhil K. Medhi.
6) Advanced organic chemistry 6 ed 2007 –Jerry March
7) Principles and Applications of Stereochemistry - Michael North, Stanley Thornes (Publishers) Ltd
8) Organic Chemistry by Paula Y. Bruice, 6th Edition

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SEMESTER-VI

Course/ Paper Title	**Physical Chemistry-II**
Course Code	**21SBCH361**
Semester	**VI**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Content

Sr. No.	Chapter Title	No. of Lectures
1.	Electrochemical Cells	09
2.	Applications of Electrochemical Cells	07
3.	Crystal Structure	10
4.	Nuclear Chemistry	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.	Fundamentals of Radioactivity, Types and kinetics of Radioactive decay, tracer applications of radioisotopes and the concept of stability based on binding energy.

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 Nuclear Chemistry student will able to learn: - 1. The concept of Radioactivity 2. Types and properties of radiations: alpha, beta and gamma 3. Detection and Measurement of Radioactivity: Cloud chamber, Ionization Chamber, Geiger-Muller Counter, Scintillation Counter, Film Badges. 4. Types of radioactive decay: α- Decay, β-Decay and γ-Decay 5. The Group Displacement Law, Radioactive Disintegration Series 6. Kinetics of Radioactive Decay, Half-life, average life and units of radioactivity 7. Energy released in nuclear reaction: Einstein's equation, Mass Defect, Nuclear Binding Energy, 8. Application of radioisotopes as a tracer: Chemical investigation-

	Esterification, Friedel -Craft reaction and structure determination w.r.t PCl5, Age determination use of tritium and C14 dating. 9. Solve the problems based on kinetics of radioactive decay and binding energy.

Syllabus

Unit No.	Title With Content	No. of Lectures
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, Thermodynamics of reversible cells and reversible electrodes, E.M.F. and equilibrium constant of cell reaction, Electrochemical series, Types of concentration cells, liquid junction potential, salt bridge Ref.-1: 1154-1178 Ref.-2: 835-880	09
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 Vs fuel cell. Ref.-3: 320-412 Ref-4: 1789-1888	07
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. Ref.-1: 491-507, 518-528 Ref.-2: 1165-1180	10
IV	**Nuclear Chemistry:** Introduction, Radioactivity, Types of Radiations, Properties of Radiations, Detection and Measurement of Radioactivity: Cloud chamber, Ionization Chamber, Geiger-Muller Counter, Scintillation Counter and Film Badges, Classification of nuclides, Types of Radioactive Decay, The Group Displacement	10

	Law, Kinetics of Radioactive Decay, Half-life, average life, Energy released in nuclear reaction, Mass Defect, Nuclear Binding Energy, Some applications of radio-isotopes as tracers: Chemical investigation – Esterification, Friedel -Craft reaction, Structural determination – Phosphorus pentachloride, Age determination – use of tritium and C14 dating, Numerical Problems. Ref.-1: 117-145	

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

Additional References:

5. Elements of Nuclear Chemistry by H.J. Arnikar
6. Physical Chemistry by G. M. Barrow, International student Edition, Mc Graw Hill.
7. University General Chemistry by C.N.R. Rao, Macmillan.
8. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
9. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
10. Principles of Physical Chemistry by S. H. Maron, C. H. Prutton, 4thE dition.
11. Chemical applications of radioisotopes by H.J.M. Brown
12. Source book of atomic energy by S. Glasstone and D. Van.
13. Modern Electrochemistry Second Edition by John O'M Bockris.

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SEMESTER-VI

Course/ Paper Title	**Physical Chemistry -III**
Course Code	**21SBCH362**
Semester	**VI**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

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

Sr. No.	Objectives
1	Partial molar quantities, Raoult's law and Henry's law.
2	Meaning of the terms- colligative properties and various application of colligative properties in physical chemistry.
3	History of polymers, Classification of polymers, Practical significance Of polymer molecular weights.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit I:** After Studying the thermodynamics of mixing student will able: - 1. To learn the terms- partial molar volume and chemical potential of perfect gases. 2. To understand the Gibbs–Duhem equation for measurement of partial molar quantities of binary mixture. 3. To understand the Gibbs energy of mixing, Entropy of mixing and Enthalpy of mixing of perfect gases. 4. To define Ideal and Ideal-dilute solutions. 5. To understand the Raoult's law and Henry's law.
2	**Unit II:** 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. 4. To understand the application of colligative properties to determine molecular weight of nonelectrolyte, abnormal molecular weight.
3	**Unit II:** After Studying the polymers student should be able :- 1. To understand the Classification of polymers. 2. To learn chemical bonding & Molecular forces in Polymers.

	3. To understand the terms- Molecular weight of polymers. 4. To solve problems based on polymer molecular weights.

Syllabus

Unit No.	Title with Contents	No. of Lectures
1.	**The thermodynamics of mixing:** Partial molar quantities, Partial molar volume, Partial molar Gibbs energies, the wider significance of the chemical potential, The Gibbs–Duhem equation, The Gibbs energy of mixing of perfect gases, Entropy of mixing of perfect gases, Enthalpy of mixing of perfect gases, the chemical potentials of liquids, Ideal solutions (Raoult's law), Ideal-dilute solutions (Henry's law), problems based on thermodynamics of mixing and Raoult's law. **Ref. No:1,** Page No. 136-147. **Ref. No:6,** Page No. 89-113.	**08**
2.	**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. No: 2,** Page No. 778 – 800. **Ref. No: 3,** Page No. 614 – 684.	**16**
3.	**Polymers:** Introduction to Polymer Chemistry, Brief History, Polymer definition, Preparation, Classification, Structures, Chemical bonding & Molecular forces in Polymers. Molecular weights of polymers: Average Molecular weight, Number Average & Weight Average Molecular weight, Molecular weight & degree of polymerisation, Practical significance Of	**12**

	polymer molecular weights, Molecular weight determination by End Group Analysis & Viscosity method and Problems based on Number Average & Weight Average Molecular Weight. **Ref. No: 4,** Page No. 1-14, 86-89, 92, 96-98, 402-409. **Ref 5:** Page No. 1-16.	

Reference Books:

7. Atkins' Physical Chemistry by Peter Atkins, Julio de Paula, James Keeler -8th edition
8. Principles of physical chemistry by B.R. Puri, L.R. Sharma, M.S. Pathania
9. Essentials of Physical chemistry by Bahl Tuli-Revised Multicolour Edition 2009, S. Chand and Company Ltd.
10. Polymer Science by V.R. Gowarikar, N.V. Vishvanathan, Jaydev Shreedhar New Age International Ltd. Publisher 1996.(Reprint 2012).
11. Textbook of Polymer Science by Fred Billmeyer, Third Edition. A Wiely-Interscience Publication John Wiely & Sons New York 1984. (Reprint 2008).
12. Physical chemistry by David W. Ball.

Additional References:

1. Physical Chemistry by Thomas Engel, Philip Reid, Warren Hehre.
2. A textbook of Physical chemistry by K. L. Kapoor, Volume-3, Fifth Edition.

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SEMESTER-VI

Course/ Paper Title	Physical Chemistry Practical-II
Course Code	**21SBCH363**
Semester	**VI**
No. of Credits	**2 (48 Lectures of 50 Minutes)**

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	Detection and measurements of nuclear radiations
4	Applications of colligative properties for electrolytes and non-electrolytes
5	Principle of turbidimetry and viscosity measurement through its experimental method
6	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 estimate the plateau voltage, resolving time and Emax of beta particle by using the G.M. Counter.
4	To understand the principle and applications of colligative properties for the estimation of molecular mass and abnormal molecular mass of non-electrolytes and electrolytes.
5.	applications of turbidimetric and viscosity measurement techniques for the qualitative and quantitative estimations
6.	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 Four)**	
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	1

	pH value of these and unknown solution	
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
5.	To determine the solubility product and solubility of AgCl potentiometrically using chemical cell.	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 Three)	
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
11.	To determine the acid and base dissociation constant of an amino acid and hence the isoelectric point of an acid.	1
	Section C: Radioactivity (Any One)	
12.	To determine plateau voltage of the given G M counter.	1
13.	To determine the resolving time of GM counter.	1
14.	To determine Emax of beta particle.	1
	Section D: Colligative Properties of Dilute Solution (Any One)	
14.	To determine the molecular weight of solute by depression in freezing point method.	1
16.	To study the association of Benzoic acid in benzene by Beckmann Method.	1
17.	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 E: Turbidometry, Polymer Chemistry and Viscometry: (Any Two)	
18.	To determine the amount of sulphate (SO_4^{2-}) and chloride (Cl^-) by turbidimetric method (turbidimetric titration or calibration curve method)	1
19.	To determine the molecular weight of a given polymer by turbidometry	1
20.	To determine the molecular weight of a high polymer by using solutions of different concentrations.	1
21.	To determine the radius of glycerol molecule from viscosity measurement.	1
	Section F: Table Work (Compulsory)	
22.	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

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	**Inorganic Chemistry-II**
Course Code	**21SBCH364**
Semester	**VI**
No. of Credits	**02 (36 Lectures of 50 Minutes each)**

Content

Unit No.	Chapters with contents	No. of lecture
I	**Organometallic Chemistry**	**10**
II	**Homogeneous and Heterogeneous catalysis**	**08**
III	**Bioinorganic Chemistry**	**06**
IV	**Inorganic Polymers**	**06**
V	**Lithium Batteries**	**06**
	Total	**36**

Aims & Objectives of the Course:

Sr. No.	Objectives
1	To understand the nature of M-C bond and the formation of multiple bonding in the organometallic compounds. Also, to understand the uses of organometallic compounds in the homogenous catalysis.
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 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.
4	To know about inorganic polymers and their types. To know the synthesis, structures of inorganic polymers and their use.
5	To understand the types and functionalities of batteries specially Pb-acid and lithium-ion batteries.

Expected Course Specific Learning Outcomes:

Sr. No.	Specific Learning Outcomes
1	**Unit I:** **Students should be able:** 1. To understand M-C bond and to define organometallic compounds. 2. To define organometallic chemistry. 3. To understand the multiple bonding due to CO ligand. 4. To know methods of synthesis of binary metal carbonyls. 5. To understand the structure and bonding using valence electron count (18-electron rule). 6. To understand the catalytic properties of binary metal carbonyls. 7. To understand the uses of organometallic compounds in the homogenous catalysis. 8. To know the chemistry of ferrocene
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:** **Student should be able to:** 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.
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. To know about batteries, to understand the types and functionalities of batteries specially Pb-acid and lithium-ion batteries.

Syllabus:

Unit No.	Chapters with contents	No. of Lectures
I	**Organometallic Chemistry:** Definition of Organometallic compounds and Organometallic chemistry,	**10**

	CO as a π-acid donor ligand, binary metal carbonyls, classification of metal carbonyls, synthesis of metal carbonyls; (a) Direct reaction (b) Reductive carbonylation (c) Photolysis and thermolysis. Hepticity, Molecular and electronic structures of binary metal carbonyls, Electron count in complexes (18 electron rule). Applications of organometallic compounds in industrial catalysis (list of examples). Chemistry of ferrocene; Introduction, synthesis and physical properties of ferrocene. Reactions of ferrocene such as Friedel-Craft Acylation, Friedel-Craft Alkylation, Mannich reaction, Nitration and Halogenation. [Further Reading: Student should also read about the interaction of different organic ligands with metals and their possible bonding.] **Ref. 1 Page No 534-542, 553-564.**	
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	**Bioinorganic Chemistry:** Introduction, Role of metals in bioinorganic chemistry, Classification as enzymatic and nonenzymatic metals, enzymatic redox metals such as Cu (SOD) and enzymatic non-redox metals such as Zn (Hydrolase). Role of metal ions in non-enzymatic processes-Na, K, Ca, Mg (one example of each and brief discussion). Role of metals in enzymatic processes-Transition metals- Catalase, peroxidase and nitrogenase (Redox active). II. Metalloproteins-Iron proteins- Introduction of Fe-S proteins, Electron transfer proteins (Fe-S, Fe2S2, Fe3S4, Fe4S4). Transport protein (transferrin) and Storage protein (ferritin) III. Bioinorganic Chemistry of Fe: Haemoglobin and myoglobin, its structure and functions and IV. Bioinorganic Chemistry of Co: Vitamin-B12, its structure and function. [Further Reading: Student should also read about the role of other metals and advanced development in the field of Bioinorganic Chemistry.] **Ref. 5 Page No. 353, 775, 779, 796-797.** **Ref .6 Page No.782-806.** **Ref. 7. Page No. 1-13, 24, 285-290.**	**06**
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 Page No. 110-129, 179-186, 207-217.**	**06**
V	**Lithium Batteries:** Introduction, types of batteries, primary and secondary batteries, battery components and their role, Characteristics of batteries, Pb-acid, Li-Battery, Solid state electrolyte battery, lithium batteries, lithium-ion batteries, differences between lithium and lithium-ion batteries, working and applications. **Ref. 9 Page No. 1.3 to 1.17,14.1 to 14.99.** **Ref.10 Page No.65-86**	**06**

Reference Books:

1. Inorganic Chemistry – D. F. Shriver, P. W. Atkins, C. H. Lamgford – Oxoford, 5th Edition,
2. Inorganic Chemistry D. F. Shriver and P. W. Atkins, 5th Edition, Oxford University Press.
3. Homogeneous Catalysis: Mechanisms and Industrial Applications, S. Bhaduri and D. Mukesh, Wiley, New York.
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. Inorganic polymer chemistry by Pimpalpure, Jain, Soni, Sahai, Pragati Edition 2012.
9. Handbook of Batteries by David Linden, Thomas B. Reddy 3rdEdition
10. Handbook of Lithium Ion Batteries of pack design By John Worner.

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SEMESTER-VI

Course/ Paper Title	**Inorganic Chemistry-III**
Course Code	**21SBCH365**
Semester	**VI**
No. of Credits	**02 (36 Lectures of 50 Minutes each)**

Content

Sr. No	**Chapters with contents**	**No. of lecture**
1	**Metals, Semiconductors and Superconductors**	**10**
2	**Ionic Solids**	**10**
3	**Inorganic Reaction Mechanism**	**08**
4	**Introduction to Molecular Symmetry**	**08**
	Total	**36**

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 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.
3	To study about the stability of complexes in aqueous solutions, classification of reactions of coordination compounds and understand the mechanisms of ligand substitution reactions, to know about the Tran's effect and its applications.
4	To understand the concept of symmetry, symmetry elements and symmetry operations with the help of examples, concepts of a group and representations of symmetry groups, point groups and space groups.

Expected Course Specific Learning Outcomes:

Sr. No.	Specific Learning Outcomes
1	**Unit I:** **Students should be able to understand:** 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. Know the nature of solids and the different types of crystal structures of solids. 3. Draw cubic, BCC and FCC crystal structures. 4. Identify the coordination number of an ion in an ionic solid. Identify the types of void. 5. Know the effect of radius ratio in determining the crystal structure. To define Pauling's univalent radius and crystal radius. 6. Be able to solve the problems based on Pauling's univalent radii and crystal radii. 7. Know how to draw Born-Haber cycle and to solve problems based on Born- Haber cycle. 8. Know the defects in ionic solids. To understand various types of crystal defects.
3	**Unit III:** **Students should be able to:** 1. To understand about inert and labile complexes and stability of complexes in aqueous solutions 2. Classification of reactions of coordination compounds 3. The basic mechanisms of ligand substitution reactions. 4. Substitution reactions of square planer complexes. 5. Tran's effect and applications of Trans effect 6. Stereochemistry of mechanism 7. Gain the knowledge of inorganic reaction mechanisms available in the literature to solve chemical problems.
4	**Unit IV:** **Students should be able to:** Student should understand and learn; 1. Basic concepts of symmetry

	2. The concept of symmetry elements and symmetry operations, representations of symmetry groups, Point Groups with examples

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**	**10**
II	**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. 4 Page No.: 32-61** **Ref No. 5 Page No.: 102-127** **Ref No. 6 Page No.: 52-62**	**10**
III	**Inorganic Reaction Mechanism:** Basic concepts of stability and lability, stability constants, Factors affecting lability, chelate effect. Classification of inorganic reactions, ligand substitution reactions: Intimate and stoichiometric mechanism of ligand substitution. Substitution Reactions in Four Coordinated tetrahedral and square planar complexes: Trans effect and Trans effect series, applications of trans effect, stereochemistry of substitution. [Further reading: Student should also read about the relation between kinetics and mechanism. Reaction mechanisms in complexes with C.N. 4, 5 and 6] **Ref No. 7 Page No.: 537-576** **Ref No. 8 Page No.: 507-517** **Ref No. 9 Page No.: 412-420, 434-440**	**08**

IV	**Introduction to Molecular Symmetry:** Symmetry elements and operations, Symmetry planes and reflections, the inversion centre, proper axis and proper rotations, improper axes and improper rotation, products of symmetry operations, equivalent symmetry elements and equivalent atoms, general relations among symmetry elements and symmetry operations, representations of symmetry groups, point groups with examples. **Ref No. 10 Page No.: 21-70** **Ref No. 11 Page No.: 01-35**	**08**

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 - 3rd edition
4. Concise Inorganic Chemistry by J.D. Lee - 5th edition
5. Concept and Model of Inorganic Chemistry by Douglas–Mc Daniels - 3rd edition
6. New Guide to Modern Valence Theory by G.I. Brown - 3rd edition
7. Inorganic Chemistry – Principles of Structure and Reactivity, J. E. Huheey, E. A. Keiter & R. L. Keiter, 4th Edn. Harper Collins College Publ. New York
8. Inorganic Chemistry – D.F. Shriver, P.W. Atkins, C.H. Lamgford – Oxoford, 5th Edn., 1994
9. Inorganic Chemistry - Messler and Tarr - Pearson Publishers
10. Symmetry and spectroscopy of molecules by K. Veera Reddy
11. Group Theory and its Chemical Application, P. K. Bhattacharya

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SEMESTER-VI

Course/ Paper Title	**Practical Course in Inorganic Chemistry-II**
Course Code	**21SBCH366**
Semester	**VI**
No. of Credits	**(02, 48L)**

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

Sr. No.	Objectives
1	To learn about volumetric estimations and significance in quantitative analysis.
2	To estimate metal ions by flame photometry.
3	To carry out separation of cations by chromatographic methods.
4	To carry out synthesis of complexes and to study of metal ligand ratio.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	Students should understand and confirm the principles of volumetric analysis.
2	Students should learn instrumental techniques for the detection of metal ions.
3	Student should learn the principles of separation of ions by chromatographic methods.
4	Student should be able to analyse the compositions of metal ions using various techniques.

Syllabus:

Sr. No.	Title with Contents	Practical Sessions
Section A: Volumetric Estimations (Any Four)		
1.	Analysis of Phosphate (PO_4^{3-}) from Fertilizer.	1
2.	Analysis of Cu from Cu-Fungicide.	1
3.	Strength of medicinal H_2O_2	1
4.	Analysis of Iodine from Iodized salt.	1
5.	Analysis of Calcium from milk powder.	1
Section B: Flame Photometric Estimation of Na/K from given water sample (Any 03)		
6.	Estimation of Na by flame photometry by calibration curve method	1
7.	Estimation of Na by flame photometry by regression method.	1

8.	Estimation of K by flame photometry by calibration curve method.	1
9.	Estimation of K by flame photometry by regression method.	1
Section C: Column Chromatography (Any One)		
10.	Separation of binary mixture of cations by Column Chromatography and qualitative analysis of cations.	1
11.	Determination of total cation concentration in water.	1
Section D: Compulsory Experiment (Any Four)		
12.	Verification of periodic trends using solubility of alkaline earth metal hydroxides $Ca(OH)_2$,$Mg(OH)_2$, $Cr(OH)_2$, $Ba(OH)_2$	1
13.	Synthesis of amine complexes of Ni (II) and its ligand exchange reaction by substitution method. (bidentate ligands like acac, DMG, Glycine)	1
14.	Determination of the metal to ligand ratio (M : L) in complexes.	1
15.	Microwave assisted, solvent free and one pot synthesis of pthalocynin copper (II) complex.	1
16.	To study Fenton reaction: Degradation of H_2O_2 using Fe catalyst.	1

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. General Chemistry Experiment – Anil J Elias (University Press).
3. Nanotechnology: Principles and Practices by Dr.Sulbha Kulkarni. Third Edition, Springer
4. A laboratory course in nanoscience and nanotechnology, Dr. Gerrad Eddy Jai Poinem, CRCpress
5. Experimental Inorganic Chemistry, Mounir A. Malati, Horwood Series in Chemical Science (Horword Publishing, Chichester) 1999.
6. Environmental Chemistry Microscale Laboratory Experiments, Jorge G. Ibanez Margarita Hemandez-Esparza Carmen Doria-Serrano Arturo Fregoso-Infante, Springer

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SEMESTER-VI

Course/ Paper Title	**Organic Chemistry-II**
Course Code	**21SBCH367**
Semester	**VI**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Content

Unit No.	Title	No. of Lecture
I	**Introduction to Spectroscopy**	**03**
II	**Ultra Violet and Visible Spectroscopy**	**07**
III	**Infra-Red Spectroscopy**	**08**
IV	**Nuclear Magnetic Resonance Spectroscopy (PMR)**	**10**
V	**Combined problems on U.V., I.R. and PMR spectroscopy**	**08**

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
1.	**Unit 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**	**03**
2.	**Unit 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**	**07**
3.	**Unit 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**
4	**Unit IV: Nuclear Magnetic Resonance Spectroscopy (PMR)** Introduction, Principles, Magnetic and nonmagnetic nuclei, nuclear	**10**

	resonance, chemical shift, shielding, & de-shielding effect. Measurement of chemical shift, TMS as reference and its advantages, peak area, integration, spin-spin coupling, coupling constants, J-value, problems based on NMR. **Ref. 2: Page Nos. 176-282**	
5	**Unit 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.	**08**

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	**Organic Chemistry-III**
Course Code	**21SBCH368**
Semester	**VI**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Content

Unit No	Name of the Unit	No. of Lecture
I	**Retrosynthetic Analysis and Applications**	**06**
II	**Organic Reaction Mechanism and Synthetic Applications**	**12**
III	**Reagents in Organic Synthesis**	**10**
IV	**Natural Products**	**08**

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 conceptual understanding of intermediates formed in organic reactions, mechanisms of select named reactions.
3	To develop the understanding of oxidation and reduction reactions and applications of various oxidising and reducing agents.
4	To introduce natural product chemistry with preliminary details and to give an idea of structure determination of citral and ephedrine through chemical and spectroscopic methods.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit I 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.
2	**Unit II Organic Reaction Mechanism and Synthetic Applications** The students will develop understanding of mechanisms of various named reactions along with the reaction intermediates. They will be able to predict the products and

	solve the problems with mechanisms.
3	**Unit III Reagents in Organic Synthesis** The student will be able to use oxidizing and reducing agents as per the requirement of questions and develop problem solving skills.
4	**Unit IV Natural Products** The student will get introduction to the two major classes of natural products viz. terpenoids and Alakloids, Their Classifications, Extraction and isolation. Structure determination and synthesis and Citral and Ephedrine with the help of chemical and spectroscopic methods.

Syllabus

Unit No.	Title with Contents	No. of Lectures
I	**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 1 Page No.: 1-34** **Ref 2 Page No.: 694-722**	**08**
II	**Organic Reaction Mechanism and Synthetic Applications** Chemistry of reactive intermediates (carbocations, carbanions, free radicals, carbenes, nitrenes, benzynes), Wolff rearrangement (Step up), Hofmann rearrangement (Step down), Simmons-Smith Reaction, Michael Reaction, Wittig Reaction, McMurry Reaction, Diels-Alder Reaction **Ref. 2 Page No.: 237-238, 500, 877-893, 982-983, 1009-1018, 1021-1022**	**08**
III	**Oxidation and Reduction** Reagents- Preparation and Applications of following reagents. **Reducing Reagents:** Lithium aluminium hydride $LiAlH_4$, $NaBH_4$, DIBAL-H, $Li(tBuO)_3AlH$ & Raney Nickel. **Oxidizing Reagents:** DMSO either with DCC or Ac_2O, Dess Martin reagent, Osmium tetroxide, Selenium dioxide-(SeO_2), DDQ **Ref. 2 Page No.: 26, 39, 131-132, 226, 537, 545, 764, 828, 919, 1123-1126**	**10**
IV	**Natural Products** **Terpenoids:** Introduction, Isolation, Classification. Citral- structure determination using chemical and spectral methods, Synthesis of Citral by Barbier and Bouveault Synthesis. **Alkaloids:** Introduction, extraction, Purification, Some examples of alkaloids and their natural resources. Ephedrine- structure determination using chemical methods. Synthesis of Ephedrine by Nagai. **Ref 2 Page No.: 1413-1447**	**10**

Reference Books:

1. Designing Organic Synthesis by Stuart Warren 1983.
2. Organic Chemistry by Clayden, Greeves, Warren and Wothers. Second edition.

Additional References:

1. Modern College Chemistry, K.D Sharma and Y. R. Sharma, Kalyani Publishers
2. University Chemistry, Vol-IV, Dr. U. N. Dash, Dr. K. K. Ojha, Himalaya Publishing House

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SEMESTER VI

Course/ Paper Title	**Organic Chemistry Practical-II**
Course Code	**21SBCH369**
Semester	**VI**
No. of Credits	**2 (73 Lectures of 50 Minutes)**

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	**D) Interpretations of IR and PMR Spectra** The students will be able to explain how "fingerprint region" of an infrared spectrum can be used in the identification of an unknown compound. Identify the functional group or groups present in a compound. Identify the broad regions of the infrared spectrum in which absorptions are caused by N−H, C−H, and O−H, C≡C and C≡N, C=O, C=N, and C=C. Understand use of NMR spectra to determine the structures of compounds. Interpret integration of NMR spectra Calculate coupling constants from 1 H NMR spectra.

Syllabus

Sr. No.	Title with Contents	Practical Sessions
	Section A: Organic Estimations (Any Three)	
3.	Estimation of glucose	1
4.	Estimation of glycine	1
5.	Saponification value of oil	1
6.	Estimation of Alkali content in Antacid using HCl.	1
	Section B: Organic Extractions (Any Three)	
7.	Caffeine from tea leaves	1
8.	Eugenol from cloves	1
9.	Lycopene from tomato peels	1
10.	Cinnamic acid from cinnamon	1
11.	Trimyristin from nutmeg	1
	Section C: Column Chromatography	
12.	Separation of mixture of aldehyde and carboxylic acid by column chromatography	1
13.	Separation of mixture of O-nitrophenol and P-nitrophenol by column chromatography	1
	Section D: Interpretation of IR and NMR spectra (2 Experiments of each type)	
14.	Determination of functional group of organic compounds from given IR spectra.	1
15.	Determination of structure of organic compound from given NMR spectra. (Ethyl alcohol, Cis-2-butene, Trans-2-butene, Benzoic acid, Propanaldehyde, Ethyl methyl ether, 1 Butyne, Ethyl acetate, Propyl Cyanide, Salicylic Acid, Nitro phenols, Isopropyl benzene, Propanamine, Benzamide, n-Pentane, 2-chloro butane, Acetophenone)	1

References:

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

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SEMESTER-VI

Course/ Paper Title	**Chemistry of Soil and Agrochemicals (A)**
Course Code	**21SBCH3610A**
Semester	**VI**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Contents

Unit No.	Unit Title	No. of Lectures
I	**Soil Chemistry**	**06**
II	**Problematic Soil and Soil testing**	**06**
III	**Laboratory Methods of Soil Analysis**	**12**
IV	**Fertilizers and Manures**	**06**
V	**Protection of Plants**	**06**

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

Sr. No.	Objectives
1.	The meaning of terms associated with coordination compounds and give IUPAC Names of Coordination Compounds,
2.	To Explain Werner's theory of coordination compounds. Differentiate between primary and secondary valency. Correlate coordination number and structure of complex ion.
3.	Functional Group Chemistry of Alkyl and Aryl Halides, Alcohol, Ether and Amines with mechanistic aspects of important reactions
4.	The skills required for converting a given molecule into a target molecule through multiple step reaction

Expected Course Specific Learning Outcomes

Sr. No.	Outcomes
1.	Understood various components of soil and soil properties and their impact on plant growth.
2.	Understood the classification of the soil.
3.	Explores the problems and potentials of soil and decide the most appropriate treatment for land use.

4.	Understood the Reclamation and management of soil physical and chemical constraints.
5.	Useful in making decisions on nutrient dose, choice of fertilizers and method of application etc. practiced in crop production.
6.	Got experience on advanced analytical and instrumentation methods in the estimation of soil.
7.	Understood various Nutrient management concepts and Nutrient use efficiencies of major and micronutrients and enhancement techniques.
8.	Proper understanding of chemistry of pesticides will be inculcated among the students.
9.	Imparts knowledge on different pesticides, their nature and, mode of action and their fate in soil so as to monitor their effect on the environment.

Syllabus

Unit No.	Title With Content	No. of Lectures
I	**Soil Chemistry:** Role of agricultural chemistry, Introduction to soil chemistry, definitions of soil, Soil components- Mineral component, organic matter or humus, soil atmosphere, soil water, soil microorganism, Physical properties of Soil- Soil texture, soil structure, soil colour, soil temperature, soil density, porosity of soil, Surface soil and sub-soil, Functions of soil, Chemical properties of soil - Soil reactions, importance of soil reaction, factors controlling soil reactions, Buffer action, buffering capacity, importance of buffer reaction in agriculture, ion exchange and importance of ion exchange. **Ref 1 Page No.: 8-12, 92-94, 98-113, 116-146** **Ref 3 Page No.: 28-50** **Ref 12 Page No.: 211-224, 228-234** **Ref 17 Page No.: 49-56, 295-308, 357-370**	**06**
II	**Problematic Soil and Soil Testing:** Introduction to problematic soils. Acid soils- formation of acid soil, effect of soil acidity on plant, reclamation of acidic soil, application of lime in improving the acidity of soil, lime requirements, Alkali Soil- formation of alkali soil, reclamation of alkali soil, Classification of alkali soil- saline soil, alkali soil, saline alkali soil, non-saline alkali soil, Soil testing - Introduction, different methods of soil fertility evaluation, Objectives of soil testing. **Ref 1 Page No.: 345-370** **Ref 3 Page No.: 301-312** **Ref 4 Page No.: 135-147, 150-159** **Ref 12 Page No.: 237-246, 337-353**	**04**
III	**Laboratory Methods of Soil Analysis:** Collection of soil Samples from field, Soil sample preparation for analysis of various parameters, Digestion and Extraction Procedures for soil, Project/ Hands on training of Analysis of various parameters of soil and writing project on it. Note: Students can perform minimum six experiments out of eight in the laboratory with the help of teacher and write report on it and submit to subject teacher. 1. Determination of pH of soil 2. Determination of EC and TDS of soil 3. Determination of soil organic matter of soil.	**07**

	4. Determination of available nitrogen in soil. 5. Determination of available phosphorus from soil. 6. Determination of calcium and magnesium from soil by EDTA method. 7. Determination of sodium and potassium by flame photometry method. 8. Determination of carbonate and bicarbonates from soil. 9. Calculate the RSC, SAR, SSP, and Salinity of soil. Interpretation of soil data and recommendations for soil use. **Ref 18 Page No.: 11-160** **Ref 19 Page No.: 17-104**	
IV	**Fertilizers and Manures:** **Fertilizers:** Introduction, Classification of nitrogenous fertilizers, reaction of ammonium sulphate, urea as a fertilizer in soil, Nano fertilizers- Nano-Fertilizers for Sustainable Crop Production, Nano urea-preparation, forms and application of nano urea, Phosphatic fertilizers- Classification of phosphatic fertilizers, reactions of superphosphate as a fertilizer in soil, Potassic fertilizers - Classification of potassic fertilizers, reactions of potash fertilizer in soil, Complex fertilizers- Characteristics, advantages and disadvantages, Mixed fertilizers - Characteristics, advantages and disadvantages, Time and mode of applications of fertilizers in the solid and liquid form to plants. Factors affecting efficiency of fertilizers. **Manures:** Introduction, Definition and classification of manures, Effect of bulky organic manures on soil, Farm yard manures (FYM), improved methods of handling FYM- Trench method for FYM, Factors affecting the composition of FYM, losses during the handling and storage of FYM, Gober gas-compost plant - construction and advantages, Biofertilizers - Definition, classification, role & advantages, Vermicompost - Preparation, effect of vermicompost on soil fertility. **Ref 2 Page No.: 205-213** **Ref 3 Page No.: 90-112, 137-149** **Ref 5 Page No.: Relevant pages** **Ref 12 Page No.: 263- 275, 280-290**	**09**
V	**Protection of Plants:** Classification of pesticides, Insecticide- Definition, Classification on the basis of mode of action and chemical properties, Inorganic insecticides - plants or animal origin insecticides- nicotine, pyrethrum, rotenone, Synthetic organic insecticides - a) Organochlorine insecticides - DDT, BHC, Aldrin and dieldrin. b) Organophosphorus insecticides – Parathion, Malathion, c) Carbamate insecticides – Carbaryl, Baygon, Fungicide - Definition and Classification of fungicides, Inorganic fungicide- Copper fungicides a) Bordeaux mixture, b) Copper oxychloride. Organic fungicides- Dithiocarbamate, Quinone fungicides, Heterocyclic fungicides, Synthetic fungicides, Herbicides- Definition, Classification on the basis of mode of action- Selective and non- selective herbicides, classification based on their effect on weeds- contact, systemic herbicides. Classification on the basis of their chemical structures, Nano pesticides: Its Scope and Utility in Pest Management **Ref 6 Page No.: Relevant Pages**	**09**

	Ref 13 Page No.: 80-177 **Ref 14 Page No.: 73-110** **Ref 15 Page No.: 1-45** **Ref 16 Page No.: 2-16**	

Reference Books:

1. A text book of soil science (Revise Edition) J. A. Daji. Revised by J. R. Kadam, N. D. Patil,Media promoters and publishers, Mumbai, 1996.
2. Text book of soil science, T. D. Biswas, S. K. Mukherjee, 2nd ed. Tata McGraw Hill Publishing company, New Delhi, 2017.
3. Introduction to Agronomy and soil, water management, V. G. Vaidya, K. R.Sahashtrabuddhe, (Continental Prakashan).
4. Principals of soil science, M. M. Rai, 4th ed. Million complex of India, Bombay, 1977.
5. Manures and fertilizers (12th ed.), K. S. Yawalkar, J. P. Agarwal and Bokde, Agri-horticulture publishing house, Nagpur, 2016.
6. Chemistry of insecticides and fungicides, U.S. Sreeramula (2nd ed.), oxford and IBH Publishing company, New Delhi.
7. Fundamentals of soil sciences, Henry D. Foth, 8th ed. John Wiley and Sons, 1990. Book Softcopy URL: https://1lib.in/book/634160/343570
8. Soil, Plant, Water and fertilizer analysis, P. K. Gupta, 2nd ed. Agrobios Publication, Jodhpur, India. Book Soft copy URL: https://content.kopykitab.com/ebooks/2016/06/7111/sample/sample_7111.pdf
9. Handbook of Biofertilizers and biopesticides, A. M. Deshmukh, R. M. Khobragade and P. D. Dixit, Oxford Book Company, Jaipur, India 2007. Book Soft copy URL: https://1lib.in/book/961124/8ecdcd
10. Essential Plant Nutrients uptake use efficiency and Management, M. Naeem, Abid A. Ansari, Sarvajeet Singh Gill Editor, Springer International Publishing AG, 2017. Book Soft copy URL: https://1lib.in/book/3376008/16ba17
11. The Use of Nutrients in crop plants, N.K. Fageria, CRC Press, Taylor and Francis Group,LLC, 2009. Book Soft copy URL: https://1lib.in/book/550595/3a2232
12. Agronomic Handbook – Management of crops, soils and their fertility, J. Benton Jones, Jr. CRC Press LLC, Washington D.C. 2003. Book Soft copy URL: https://1lib.in/book/946311/37a879
13. The chemistry of Organophosphorus Pesticide, Christa Fest, Karl-Julius Schmidt, 2nd reviseded., Springer, Verlag Berlin Heidelberg, New York, 1982. Book Soft copy URL: https://1lib.in/book/2137868/423f0a
14. Chemical Pesticide - Mode of action and Toxicology, Jorgen Stenersen, CRC Press, 2004.Book Soft copy URL: https://1lib.in/book/550607/97f6b8
15. Agrochemical and Pesticide safety Handbook, Michel F. Waxman, CRC Press, 1998. BookSoft Copy URL: https://1lib.in/book/2061906/6282cc
16. Basic Guide to Pesticides: Their Characteristics and Hazards, Shirley A. Briggs, Rachel Carson Council, First Edition, CRC Press, Taylor and Francis Group, 2017. Book Soft copyURL: https://1lib.in/book/3580723/94db6c
17. Principles of Soil Chemistry, Kim H. tan, 4th ed. revised and expanded, Marcel Dekker AG,New York, 1998. Book Soft copy URL: https://1lib.in/book/2572952/f500e1
18. Laboratory Guide for Conducting Soil Tests and Plant Analysis, J. Benton Jones Jr. CRCPress, 2001. Book Soft copy URL: https://1lib.in/book/665386/63e6f0
19. Agricultural Chemistry, First Edition, R. P. Dhok, Amazon Digital Services, LLP-KDP E Book, US. 2021. Book Soft copy URL: https://drive.google.com/file/d/1gnvIAzdN0aaZtKbX6TY9UZ2PC7M3ANN9/view?usp=sha ring

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SEMESTER-VI

Course/ Paper Title	**Techniques in Bioanalytical Chemistry**
Course Code	**21SBCH3610B**
Semester	**VI**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Content

Unit No.	Unit Title	No. of Lectures
I	**Bioanalysis Techniques**	**14**
II	**Biological samples**	**04**
III	**Analysis of Blood and urine**	**06**
IV	**Organ function tests**	**08**
V	**Immunoanalytical Techniques**	**04**

Content

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

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

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	**Unit I:** After Studying this unit student will able to: - 7. Develop the skills to understand the theory and practice of bioanalytical techniques. 8. Explain principles of different analytical techniques. 9. Explain the working and instrumentation of different bioanalytical techniques.
2	**Unit II:** After studying this unit student will able to: - 4. Explain the collection of bioanalytical samples.

	5. Explain the composition of blood, urine and faeces. 6. Describe the storage and preservation of bioanalytical samples for analysis.
3	**Unit III:** After studying this unit student will able to: - 6. Understand the methodology for the selection of suitable measurement techniques and methods to solve complex bioanalytical problems. 7. Understand the strengths, limitations, and creative use of techniques for problem-solving. 8. Analyse different bioanalytical samples for their composition and interpret the results. 9. Design experiments and understand the instrumentation.
4	**Unit IV:** After studying this unit student will able to: - 7. Describe role of vital organs. 8. Explain the functioning of vital organs. 9. Design a suitable method for functional assessment of vital organs.
5	**Unit V:** After studying this unit student will able to: - 6. Describe the role immunoassays for the analysis of bioanalytical samples. 7. Explain the principal and methodology of immunoassays. 8. Design experiments and understand the instrumentation of immunoassay and ELISA.

Syllabus

Unit No.	Title With Content	No. of Lectures
I	Bioanalysis Techniques: Spectroscopy: Principle, instrumentation and applications of Colorimetry, UV-Visible Spectrophotometry, Atomic Absorption Spectroscopy and Flame Emission Spectroscopy. Numerical problems. Chromatography: Principle, instrumentation and applications of Paper chromatography, thin layer chromatography (TLC), Gas chromatography and High-performance liquid chromatography (HPLC). Numerical problems. **Ref No. 1 Page No.: 119-252, 695-780** **Ref No. 2 Page No.: 3-89, 285-324**	**14**
II	Biological samples: Blood: Collection of Blood specimens, storage and preservation. Urine: Collection of Urine, physical characteristics of urea, preservation and storage. Faeces: Collection and preservation. **Ref No. 3 Page No.: 1-18** **Ref No. 4 Page No.: 7-19**	**04**
III	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. 3 Page No.: 80, 97, 110, 158, 190, 431**	**06**

	Ref No. 4 Page No.: 67-80, 204-225	
IV	Organ function tests: Liver function tests: Functions of the liver. Conjugated and total bilurubin in serum, hippuric acid synthesis test and bromsulphthalein test. Kidney function tests: Functions of the Kidney. creatinine and urea clearance tests, phenol red test. Numerical Problems. **Ref No. 3 Page No.: 168-189, 349-393** **Ref No. 4 Page No.: 107-112, 130-137, 181-198**	**08**
V	Immunoanalytical Techniques: Radioimmunoassay, its principle and applications, instrumentation for radio bioassay, Advantages of immunoassay, Principles and Types of ELISA, Applications of ELISA. **Ref No. 5 Page No.: 166-180**	**04**

Reference Books: (Inorganic Chemistry)

1. 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
2. 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.
3. Practical clinical Biochemistry, Harold Varley (4^{th} Edition), CBS publishers and Distributers. New Delhi -110002
4. Practical Clinical Biochemistry Methods and Interpretations, 4^{th} Edition by Ranjna Chawla, Jaypee Brothers Medical Publishers, New Delhi.
5. Principle and practice of Bioanalysis by Richard F. Venn, Taylor & Francis 11 New Fetter Lane, London.

Additional Reading

1. Introduction to Instrumental Analysis by R. D. Braun, Book Syndicate, 2006
2. Instrumental Methods of Chemical Analysis, by Chatwal. G. R., Anand, Sham K., 5^{th} Edition, Himalaya Publishing House, 2005
3. Introduction to instrumental methods of analysis, M. H. Gordon and R. Macrae, Springer.
4. Instrumental Methods of Chemical Analysis, Dr. B. K. Sharma, Krishna Prakashan Media, 1981
5. Bioanalytical Chemistry by Andreas Manz, Nicole Pamme and Dimitri lossif idis, Imperial College Press, London.
6. Bioanalytical Chemistry by Susan R. Mikkelsen and Eduardo Cortón, John Wiley & Sons, Inc., Hoboken, New Jersey.
7. Immunoassays: Development, Applications and Future Trends by Richard O'Kennedy and Caroline Murphy, Pan Stanford Publishing Pte. Ltd., Singapore.

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SEMISTER VI

Course/ Paper Title	**Analytical Chemistry-II A**
Course Code	**21SBCH3611A**
Semester	**VI**
No. of Credits	**2, (36 Lectures of 50 Minutes)**

Content

Unit No.	Chapter Title	No. of Lectures
I	**Solvent Extraction**	**08**
II	**Instrumental Methods of Chromatographic Analysis**	**04**
III	**High Performance Liquid Chromatography**	**06**
IV	**Gas Chromatography:**	**06**
V	**Atomic Absorption spectroscopy**	**08**
VI	**Flame Emission Spectroscopy**	**04**

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

Sr. No.	Objectives
1	To learn the separation by use of solvent extraction.
2	To understand the atomic spectroscopic methods.
3	To study the 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 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, Cupferron, Nitron, and Benzoin-alfa oxime, Anthanilic acid), Gravimetric Calculations. Applications of Gravimetry: Determination of Al(III) by 8-hydroxyquoline, Determination of phosphate as ammonium molybdophosphate, Numericals, **Ref No. 2 Page No.: 242- 253** **Ref No. 3 Page No.: 579- 593**	**08**
II	**Instrumental Methods of Chromatographic Analysis** Principles of Chromatographic Separations, classification, Theory of Column Efficiency inChromatography, (theoretical plate, rate theory of chromatography - the Van Deemter equation,efficiency and particle	**04**

	size in HPLC, retention factor efficiency and resolution **Ref No. 3 Page No.: 547-556** **Ref No. 4 Page No.: 603-617**	
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 andsample 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)**	**06**
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**	**06**
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**	**08**
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, **Ref No. 2 Page No.: 645-649, 655-656** **Ref No. 3 Page No.: 553- 556**	**04**

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-V

Course/ Paper Title	**Special Topics of Competitive Chemistry-II (B)**
Course Code	**21SBCH3611B**
Semester	**VI**
No. of Credits	**2 (36 Lectures of 50 Minutes)**

Content

Unit No.	Title of Unit	No. of lecture
I	**Chemical kinetics**	12
II	**Transition Metals (d block)**	12
III	**Pericyclic reactions and Stereochemistry of Disubstituted Cyclohexane and Decalin**	12

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

Sr. No.	Objectives
1	To provide additional knowledge on important topics in Chemistry with respect to competitive examination point of view.

Expected Course Specific Learning Outcomes

Sr. No.	Specific Learning Outcomes
1	Students should be able to solve the numerical problems, memory-based questions as well as predict the product on the basis of their understanding of reaction mechanism, knowledge of various reagents and their applications.

Syllabus

Unit No.	Title with Contents	No. of Lectures
I	**Chemical Kinetics** Chemical kinetics, Empirical rate laws and temperature dependence, complex Reactions, steady state approximation, determination of reaction mechanisms, Collision and transition state theories of rate	12

	constants, unimolecular reactions, Enzyme kinetics, primary salt effect. **Ref No. 1 Page No.: 791-820, 839-840** **Ref No. 2 Page No.: 909-946**	
II	**Main Group Elements (s and p blocks)** Characteristics of d-block elements; oxide, hydroxide and salts of first row metals; coordination complexes: structure, isomerism, reaction mechanism and electronic spectra; VB, MO and crystal field theoretical approaches for structure, color and magnetic properties of metal complexes; Organometallic compounds with metal-ligand single and multiple bonds (such as metal carbonyls, metal nitrosyls and metallocenes); Homogenous catalysis involving Wilkinson's catalyst. **Ref No. 3 Page No.: 629-638** **Ref No. 4 Page No.: 449-466** **Ref No. 5 Page No.: 407-419**	**12**
III	**Pericyclic reactions and Stereochemistry of Disubstituted Cyclohexane and Decalin** **Pericyclic Reactions** Basics of Molecular orbital of π-bond, 1,3-butadiene and 1,3,5-hexatriene and HOMO-LUMO Mechanism, stereochemistry, regioselectivity in case of Electrocyclic reactions: FMO approach involving 4π- and 6π-electrons (thermal and photochemical) and corresponding cyclo-reversion reactions. Cycloaddition reactions: FMO approach (2+2, 4+2), Diels-Alder reaction and their examples. Sigmatropic reactions: FMO approach, sigma tropic shifts and their order; [1,3], [1,5]- H shifts and [3,3]-shifts with reference to Claisen and Cope rearrangements. **Ref No. 6 Page No.: 1-10, 34-35, 81-82, 164-167** **Stereochemistry of Disubstituted Cyclohexane and Decalin** **Ref No. 7 Page No.: 204-213** **Ref No. 8 Page No.: 140-146**	**12**

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2) Physical chemistry by Thomas Engel and Phillip Reid, Third Edition
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5) Inorganic Chemistry by James E. Huheey, Ellen A. Keiter, Richard L. Keiter and Okhil K. Medhi.
6) Pericyclic reactions - A mechanistic and problem-solving approach, Sunil Kumar
7) Stereochemistry of carbon compounds by E.L. Eliel, Mc - Graw - Hill, New York
8) Chemistry of Plant Natural Products Stereochemistry, Conformation, Synthesis, Biology, and Medicine, Sunil K Talapatra, Bani T, Springer-Verlag Berlin Heidelberg 2015

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