Savitribai Phule Pune University [SPPU]

B.Sc. (Chemistry)

(Three Years Integrated Degree Program)

Choice Based Credit System [CBCS]

2019 Pattern

Third Year Bachelors of Science

(T. Y. B. Sc.CHEMISTRY)

From
Academic Year 2021-22

Board of Studies in Chemistry

Savitribai Phule Pune University [SPPU]
Pune-411007

Structure of T. Y. B. Sc. Chemistry

(According to CBCS – 2019 Pattern of SPPU)

Semester	DSEC/SEC	Nature	Paper Code	Code and Title	Credits/Lectures
V	DSEC-I	Theory	CH-501	Physical Chemistry-I	Credit-2, 36 L
		Theory	CH-502	Analytical Chemistry-I	Credit-2, 36 L
		Practical	CH-503	Physical Chemistry Practical-I	Credit-2, 73 L
	DSEC-II	Theory	CH-504	Inorganic Chemistry-I	Credit-2, 36 L
		Theory	CH-505	Industrial Chemistry	Credit-2, 36 L
		Practical	CH-506	Inorganic Chemistry Practical-I	Credit-2, 73 L
	DSEC-III	Theory	CH-507	Organic Chemistry-I	Credit-2, 36 L
		Theory	CH-508	Chemistry of Biomolecules	Credit-2, 36 L
		Practical	CH-509	Organic Chemistry Practical-I	Credit-2, 73 L
	SEC- I	Theory	CH-510	**(A)** Introduction of Medicinal Chemistry **OR** **(B)** Polymer Chemistry	Credit-2, 36 L
	SEC- II	Theory	CH-511	**(A)** Environmental Chemistry **OR** **(B)** Chemo informatics	Credit-2, 36 L
VI	DSEC-IV	Theory	CH-601	Physical Chemistry-II	Credit-2, 36 L
		Theory	CH-602	Physical Chemistry -III	Credit-2, 36 L
		Practical	CH-603	Physical Chemistry Practical-II	Credit-2, 73 L
	DSEC-V	Theory	CH-604	Inorganic Chemistry-II	Credit-2, 36 L
		Theory	CH-605	Inorganic Chemistry-III	Credit-2, 36 L
		Practical	CH-606	Inorganic Chemistry Practical-II	Credit-2, 73 L
	DSEC-VI	Theory	CH-607	Organic Chemistry-II	Credit-2, 36 L
		Theory	CH-608	Organic Chemistry-III	Credit-2, 36 L
		Practical	CH-609	Organic Chemistry Practical-II	Credit-2, 73 L
	SEC III	Theory	CH-610	**(A)** Chemistry of Soil and Agrochemicals **OR** **(B)** Introduction of Forensic Chemistry	Credit-2, 36 L
	SEC IV	Theory	CH-611	**(A)** Analytical Chemistry-II **OR** **(B)** Chemistry of Cosmetics and Perfumes	Credit-2, 36 L

Important points:

i. Each credit is equivalent to 18 lectures of 50 minutes for theory courses and 36 lecture of 50 minutes for practical courses.
ii. There will be12 practical sessions per semester of 4 hours 20 minutes each.
iii. Total weeks for teaching and internal evaluation are15. 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, SPPU, 2019 Pattern)

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 University Assessment (UEX) mechanism.
3. Continuous internal assessment shall be of 15 marks (30%) while university Evaluation shall be of 35 marks (70%).
4. To pass each course, a student has to secure 40% mark in continuous assessment as well as university assessment i.e. minimum 6 marks in continuous assessment and 14 in university assessment 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. (on approval of the head of centre).
7. Theory - University Assessment Question Paper Pattern (According to CBCS - 2019 Pattern of SPPU) 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**: 2019 pattern) and to be implemented form academic year 2021-22. 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.

Equivalence with Previous Syllabus (2013 Pattern)

2013 Pattern	2019 Pattern
Sem-III (T.Y.B.Sc.)	**Sem-V (T.Y.B.Sc.)**
Core courses	**Discipline Specific Elective Courses (DSEC)**
CH-331: Physical Chemistry	CH: 501: Physical Chemistry-I
CH-332: Inorganic Chemistry	CH: 504: Inorganic Chemistry-I
CH-333: Organic Chemistry	CH: 507: Organic Chemistry-I
CH-334: Analytical Chemistry	CH: 502: Analytical Chemistry-I
CH-335: Industrial Chemistry	CH: 505: Industrial Chemistry
CH-336: Optional course (Any one) A- Nuclear Chemistry, B- Polymer Chemistry C- Intro. To Biochemistry ,D- Env. And Green Chemistry, E- Agriculture Chemistry	CH:508: Chemistry of Biomolecules
----	**Skill Enhancement Courses (SEC)** CH:510 (A): Introduction of Medicinal Chemistry **OR** CH:510 (B): Polymer Chemistry
----	CH:511(A): Environmental Chemistry **OR** CH:511(B): Cheminformatics
Sem-IV (T.Y.B.Sc.)	**Sem-VI (T.Y.B.Sc.)**
Core courses	**Discipline Specific Elective Courses (DSEC)**
CH-341: Physical Chemistry	CH: 601: Physical Chemistry-II
CH-342: Inorganic Chemistry	CH: 604: Inorganic Chemistry-II
CH-343: Organic Chemistry	CH: 607: Organic Chemistry-II
CH-344: Analytical Chemistry	CH-602: Physical Chemistry -III
CH-345: Industrial Chemistry	CH: 605: Inorganic Chemistry-III
CH-346: Optional course (Any one) A- Nuclear Chemistry, B- Polymer Chemistry C- Intro. To Biochemistry, D- Env. And Green Chemistry, E- Dairy Chemistry	CH: 608: Organic Chemistry-III
	Skill Enhancement Courses (SEC) CH-610 (A): Chemistry of Soils and Agrochemicals **OR** CH-610 (B): Introduction of Forensic Chemistry
	CH-611 (A): Analytical Chemistry-II **OR** CH-611 (B): Chemistry of Cosmetics and Perfumes
CH-347: Physical Chemistry Practical	CH 503 and 603: Physical Chemistry Practical-I and II
CH-348: Inorganic Chemistry Practical	CH 506 and 606: Inorganic Chemistry Practical I and II
CH-349: Organic Chemistry Practical	CH 509 and 609: Organic Chemistry Practical-I and II

The Detailed Semester and Course Wise Syllabus as follows:

SEMESTER-V

DSEC-I: CH-501: Physical Chemistry- I [Credit -2, 36 L]

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Quantum Chemistry	10
2	Investigation of Molecular structure	16
3	Photochemistry	10
	Total	**36**

1. Quantum Chemistry [10 L]

Introduction, de Broglie hypothesis, The Heisenberg's uncertainty principle, quantisation of energy, Operators, Schrodinger wave equation, well behaved function, Particle in a one-, two and three-dimensional box (no derivation), Physical interpretation of the ψ and ψ2, sketching of wave function and probability densities for 1D box, degeneracy, applications to conjugated systems, zero-point energy and quantum tunnelling, Numerical

Expected learning Outcome:

After successfully completion, students will be able to:

1. Know historical of 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. Understanding of De Broglie hypothesis and the uncertainty principle
5. Understanding the operators: Position, momentum and energy
6. Solving Schrodinger equation for 1D, 2D and 3D model
7. Physical interpretation of the ψ and ψ2 and sketching the wave function
8. Applications to conjugated systems, zero-point energy and quantum tunnelling, Numerical Problems

Reference books:

1) Principles of Physical Chemistry by Puri, Sharma, Pathania,; (Page No: 21-110)
2) Essential of Physical Chemistry, Bahl and Tuli (S. Chand).; (Page No: 50-58)

2. Investigation of Molecular structure [16 L]

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, Problems

Infrared Spectroscopy: Introduction, Simple Harmonic oscillator, Modes of vibration, force constant, Vibrational spectrum of a diatomic molecule: Vibrational Energy expression, Allowed vibrational energies, zero-point energy, Selection rule, 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, 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

Expected learning Outcome: After studying this chapter, the student will be able to:

1. Understand the term additive and constitutive properties.
2. Understand the term specific volume, molar volume and molar refraction.
3. Understand 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.
8. Simple Harmonic oscillator model, Born-Oppenheimer approximation. Vibrational spectra of diatomic molecules selection rules, nature of spectral lines.
9. Explain the difference between Rayleigh, Stokes and anti-Stokes lines in a Raman spectrum.
10. Justify the difference in intensity between Stokes and anti-Stokes lines.
11. Draw the Stokes and anti-Stokes lines in a Raman spectrum
12. Raman spectra: Concept of polarizability,
13. Pure rotational Raman spectra of diatomic molecules, Energy Expression, Selection rule, Rotational energy level diagram, Rotational Raman spectrum and Problems

Reference books:

1. Fundamentals of molecular spectroscopy by C.N. Banwell and E. M. McCash.

(Page No: 33-59, 60-75, 111-119)

2. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000.
(Page No: 413-455)

3. Photochemistry [10 L]

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 Quantum yield, Experimental method for the determination of quantum yield, types of photochemical reactions - photosynthesis, photolysis, photocatalysis, photosensitization, Jablonski diagram depicting various processes occurring in the excited state: Qualitative description of fluorescence and phosphorescence, Chemiluminescence, Problems

Expected learning Outcome:

After studying this chapter, the student will be able to know and understand:

1. Difference between thermal and photochemical processes.
2. photochemical laws: Grothus - Draper law, Stark-Einstein law,
3. Quantum yield and reasons for high and low quantum yield,
4. factors affecting the quantum yield,
5. Experimental method for the determination of quantum yield
6. Photochemical reactions: photosynthesis, photolysis, photocatalysis, photosensitization
7. Various photochemical phenomena like fluorescence and phosphorescence, Chemiluminescence,
8. Problems

Reference books:

1. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).; (Page No: 1154-1178)
2. Principles of Physical Chemistry by Puri, Sharma, Pathania,; (Page No: 1112-1135)
3. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000.
(Page No: 262-2810)

Additional Reference Books:

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

7. Quantum Chemistry by I. Levine.
8. Quantum Chemistry by R.K. Prasad

DSEC-I: CH-502: Analytical Chemistry- I [Credit -2, 36 L]

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Gravimetry	09
2	Inorganic Qualitative Analysis	07
3	Thermal methods of analysis	06
4	Parameters of instrumental analysis	04
5	UV-Visible spectroscopy	10
	Total	**36**

1. Gravimetry (9 L)

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—How Much Analyte is there (Ref-3)

Applications of Gravimetry: Determination of Al(III) by 8-hydroxyquoline, Determination of calcium as oxalate; Determination of potassium as potassium tetraphenylborate, Determination of phosphate as ammonium molybdophosphate, Numericals,

Key Reference-1: 417-428, 433-444, 446, 451, 464, 485; [Supplementary Ref-2: Pp-342 to 362]

2. Inorganic Qualitative Analysis (7 L)

Basic principle, common ion effect, solubility, solubility product, preparation of original solution, classification of basic radicals in groups, separation of basic radicals, removal of interfering anions (phosphate and borate), detection of acid radicals. Ref-6

3. Thermal methods of analysis (6 L)

General discussion, Thermogravimetry, Experimental factors affecting TG analysis, Instruments for thermogravimetry, Applications: Thermogravimetric analysis of CaC_2O_4 H_2O, $CuSO_4$ $5H_2O$, Differential Thermal Analysis: Introduction, instrumentation for DTA and DSC, experimental and instrumental factors, applications: DTA of copper sulphate pentahydrate, Purity of

pharmaceutical by DSC, Key Reference-2: 503-522, [Supplementary reference, Ref-4: 884-890, Ref-1: 428-433]

3. Parameters of instrumental analysis (4 L)

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, Key Reference -5: 35-48

4. UV-Visible spectroscopy (10 L)

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: Estimation of metal ions from aqueous solution: Boron in steel, Chromium in steel with diphenyl carbazide reagent, ammonia in water, Chloride, Primary amine, Determination of phenol, 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., Numericals Key Reference-2: 658-717 and Ref-1: 645-725

References:

Ref-1: Vogel's textbook of Inorganic Quantitative Analysis, Jeffery, Basset, Mendham Deney, 5th Ed, Longman Scientific Technical, USA (copublished with John Wiley Sons)

Ref-2: Vogel's textbook of Inorganic Quantitative Analysis, Mendham, Deney Barnes, 6th Ed, Pearson education

Ref-3: Analytical Chemistry by G. D. Christian, et al , Wiley, 6th Ed.

Ref-4: Principles of Instrumental Analysis: Holler, Skoog, Crouch 6th Ed. Thomson Publication

Ref-5: Modern Analytical Chemistry, David Harvey, Mc-Graw Hill Higher education

Ref-6: Vogel's Qualitative Inorganic Analysis, G. Svehla, Pearson, 7th Ed.

Course outcome: After completion of the course student should be able to

1. Define basic terms in gravimetry, spectrophotometry, qualitative analysis and parameters in instrumental analysis. Such as: Gravimetry, precipitation, solubility product, ionic product, common ion effect, precipitating agent, washing of ppt., drying and ignition of ppt., linearity range, detection limit, precision, accuracy, Sensitivity, Selectivity, Robustness and Ruggedness, electromagnetic radiations, spectrophotometry, Beers law, absorbance, transmittance, molar absorptivity, monochromator, wavelength of maximum absorbance,

metal ligand ration, qualitative analysis, group reagent, dry tests, wet test, confirmatory test, precipitation, thermogravimetry, thermogram, percent wt. loss, differential thermal analysis, etc.

2. Identify important parameters in analytical processes or estimations. Example: minimum analyte concentration in particular method, reagent concentration in particular analysis (gravimetry, spectrophotometry, thermogravimetry), reagent for particular analysis, reaction condition to convert analyte into measurable form, drying and ignition temperature for ppt in gravimetry, heating rate thermogravimetry, wavelength in spectrophotometry, group reagent, removal borate and phosphate in qualitative analysis, etc.
3. Explain different principles involved in the gravimetry, spectrophotometry, parameters in instrumental analysis, qualitative analysis.
4. Perform quantitative calculations depending upon equations student has studied in the theory. Furthermore, student should able to solve problems on the basis of theory.
5. Discuss / Describe procedure for different types analyses included in the syllabus.
6. Select particular method of analysis if analyte sample is given to him.
7. Differentiate / distinguish / Compare among the different analytical terms, process and analytical methods.
8. Demonstrate theoretical principles with help of practical.
9. Design analytical procedure for given sample.
10. Apply whatever theoretical principles he has studied in theory during practical session in laboratory.

DSEC-I: CH-503: Physical Chemistry Practical - I [Credit -2, 73 L]

Total 12 experiments to be completed.

1. Refractometry: (any two)

1) 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.
2) To determine the molecular refractivity of the given liquids A, B, C and D.
3) To determine the molar refraction of homologues methyl, ethyl and propyl alcohol and show the constancy contribution to the molar refraction by -CH2 group.
4) Determine the refractive index of a series of salt solutions and determine the concentration of a salt of unknown solution

2. Spectrophotometry and Colorimetry (any three)

1) To titrate Cu^{2+} ions with EDTA photometrically.
2) To determine the indicator constant of methyl red indicator

3) To estimate of Fe^{3+} ions by thiocyanate method.
4) Cobalt by using R-nitroso salt method.
5) To determine the order of reaction for the oxidation of alcohol by potassium dichromate and potassium permanganate in acidic medium calorimetrically.
6) Simultaneous determination of Cu^{2+} and Ni^{2+} ions by colorimetry/spectrophotometry method

3. Conductometry (any four)

1) Titration of a mixture of weak acid and strong acid with strong alkali.
2) To determine the velocity constant of hydrolysis of ethyl acetate by NaOH solution by conduct metric method.
3) To determine the normality of citric acid in given fruit by titrating it against standard NaOH solution by conductometric method.
4) To determine $\lambda\infty$ of strong electrolyte (NaCl or KCl) and to verify Onsager equation.
5) To estimate the amount of lead present in given solution of lead nitrate by conductometric titration with sodium sulphate.
6) To determine the relative strength of monochloro acetic acid and acetic acid conductometrically

4. Viscosity: (any one)

1. To determine the molecular weight of a high polymer by using solutions of different concentrations.
2. Determine the radius of glycerol molecule from viscosity measurement.

5. Photoflurometry

1. Analysis of Riboflavin from vitamin supplementary capsules / syrup / tablet sample by Photoflurometry

6. Table work

1. Analysis of the given vibration-rotation spectrum of HCl(g)

DSEC-II: CH-504: Inorganic Chemistry - I [Credit -2, 36 L]

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Molecular Orbital Theory of Coordination Compounds	08
2	Inorganic Reaction Mechanism	06
3	Chemistry of transition elements	06
4	Chemistry of f-block elements	08
5	Metals, Semiconductors and Superconductors	08
	Total	**36**

1. Molecular Orbital Theory of Coordination Compounds (8L)

Electro-neutrality principle, multiple bonding (dπ-pπ and dπ-dπ), Nephelauxetic effect and Nephelauxetic series (Recapulation 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.

Aims and objective/Learning Outcomes: A student should know:

i. Explain electroneutrality principle and different types of pi bonding.
ii. Able to explain Nephelauxetic effect towards covalent bonding.
iii. Explain MOT of Octahedral complexes with sigma bonding.
iv. Able to explain Charge Transfer Spectra.
v. Able to compare the different approaches to bonding in Coordination compounds.

References:

1. Concise Inorganic Chemistry by J.D. Lee - 4th Edition pp226-231
2. Physical Inorganic Chemistry A Coordination Chemistry Approach S. F. A. Kettle Springer-Verlag Berlin Heidelberg GmbH, 1996 pp 95-120
3. Theoretical Inorganic Chemistry by Day and Selvin (Relevant Pages)

2. Inorganic Reaction Mechanism (6L)

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

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]

Aims and objective: A student should know:

i. To understand about inert and labile complexes and stability of complexes in aqueous solutions
ii. Classification of reactions of coordination compounds
iii. The basic mechanisms of ligand substitution reactions.
iv. Substitution reactions of square planer complexes.
v. Tran's effect and applications of Trans effect
vi. Stereochemistry of mechanism
vii. Gain the knowledge of inorganic reaction mechanisms available in the literature to solve chemical problems.

References:

1. Inorganic Chemistry – Principles of Structure and Reactivity, J. E. Huheey, E. A. Keiter & R. L. Keiter, 4th Edn. Harper Collins College Publ. New York, Chapt.13, p.537-576, (1993).
2. Martin L. Tobe and John Burgess, Inorganic Reaction Mechanisms, Addison Wesley Longman Inc., 1999.
3. Inorganic Chemistry – D.F. Shriver, P.W. Atkins, C.H. Lamgford – Oxoford, 5th Edn., 1994, pp507-517.
4. Inorganic Chemistry - Messler and Tarr - Pearson Publishers pages 412-420, 434-440

3. Chemistry of Transition elements [6L]

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.-1]

Aims and objective: A student should know:

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.

References:

1. Concise Inorganic Chemistry by J.D. Lee - 5th edition. Pages 859-863, 865-866,

4. Chemistry of f-block elements [8L]

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. [Reference-1]

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. [Reference-1]

Aims and objective: A student should know:

1. The meaning of term f-block elements, Inner transition elements, lanthanides, actinides.
2. Electronic configuration of lanthanides and actinides.
3. Oxidation states of lanthanides and actinides and common oxidation states.
4. Separation lanthanides by modern methods.
5. Lanthanide contraction and effects of lanthanide contraction on post-lanthanides.
6. Use of lanthanide elements in different industries.
7. Transuranic elements.
8. Preparation methods of transuranic elements.
9. Nuclear fuels and their applications.
10. Why transuranic elements are called as the synthetic elements?
11. IUPAC nomenclature for super heavy elements with atomic no. 100 onwards.

References:

1. Concise Inorganic Chemistry by J.D. Lee - 5th Edn. 874 – 875, 879-886, 891-893, 898-900.

5. Metals, Semiconductors and Superconductors [8L]

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,

Semiconductors, types of Semiconductors: I. Intrinsic II. Extrinsic, effect of temperature and impurity on semiconductivity, n & p type semiconductors ZnO and NiO, Superconductivity: Discovery, property, models, structure and superconductivity, low and high temperature superconductors, applications of superconductors.

Aims and Objectives: A student should be able –

1. The meaning of metal & semiconductor.
2. The difference between metal, semiconductor and insulator.
3. Metallic bond on the basis of band theory.
4. The energy band and energy curve.
5. Draw n (E) & N (E) curves.
6. Explain the electrical conductivity of metals with respect to valence electrons.
7. Explain the effect of temperature and impurity on conductivity of metals and semiconductors.
8. Intrinsic and extrinsic semiconductor.
9. The term valance band and conduction band.
10. n and p type of semiconductors.
11. Non-stoichiometry and semi conductivity.
12. Insulators on the basis of band theory.
13. The difference between Na, Mg, and Al in terms of valence electrons and conductivity.
14. Meaning of super conductors and their structure. o. Discovery and applications of superconductors.

References:

1. Solid State Chemistry: An Introduction, Lesley E. Smart, Elaine A. Moore, 3rd Edn. Relevant pages from Chapter 10, pp394-411
2. Solid State Chemistry and its Applications, Anthony R. West, Second Edition, Wiley 2014, PP 359-391
3. Chemistry by Raymond Chang - 5th edition (Related Pages)
4. New Guide to Modern Valence Theory by G.I. Brown - 3rdedition Pages 209-221

DSEC-II: CH-505: Industrial Chemistry - I [Credit -2, 36 L]

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Modern Approach to Chemical Industry	06
2	Manufacture of Basic Chemicals	07
3	Sugar and Fermentation Industry	07
4	Soap and Detergents Industry	08
5	Dyes and Pigments	08
	Total	**36**

1. Modern Approach to Chemical Industry (6 L)

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. No.-7, Relent pages, Ref. - 10: www.wikipedia.org/wiki/copyright_act_of1976/patent act/ trademark

Aims and Learning objectives: The students are expected to learn;

i. Importance of chemical industry,

ii. Meaning of the terms involved,

iii. Comparison between batch and continuous process,

iv. Knowledge of various industrial aspects

2 Manufacture of Basic Chemicals (7 L)

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.

Reference No.-1: Page No. 731 to 761, 809 to 844, Reference-3: 1128-1175, 1253-1263

Aims and Learning objectives: The students are expected to learn

i. Concept of basic chemicals,

ii. Their uses and manufacturing process.

iii. They should also know the physico-chemical principals involved in manufacturing process

3. Sugar and Fermentation Industry (7 L)

a. Sugar: 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,

Reference No.-1: Page No.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.

Reference No.-1: Page No. 1176-1184

Aims and Learning objectives: The students are expected to learn

Sugar Industry: The students are expected to learn

i. Importance of sugar industry,

ii. Manufacture of direct iii. Consumption (plantation white) sugar with flow diagram.

iii. Cane juice extraction by various methods,

iv. Clarification by processes like carbonation, vi. Sulphitation, vii. Phosphatation, etc.

v. Concentration of juice by using multiple effect evaporator system,

vi. Crystallization of sucrose by using vacuum pan.

Fermentation Industry- The students are expected to learn

i. Importance,

ii. Basic requirement of fermentation process,

iii. Manufacturing of ethyl alcohol by using molasses and fruit juice.

4. Soap and detergents (8 L)

(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,

Reference-5: 980-997, Reference-1: 1243 -1250

(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.

Reference-5: 1006-1029, Reference-1: 252 – 1279

Aims and Learning objectives: The students are expected to learn

i. Different types of soap products,

ii. Chemistry of soap.

iii. Raw materials required for soap manufacture

iv. Meaning of the term's Surfactants, Types of surfactants

v. Raw materials for detergents

vi. Detergent builders, additives

vi. Washing action of soap and detergents

5. Dyes and Pigments (8 L)

(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-quinnoe-Alizarin and Indigo dyes - Indigo.

Reference -1: pp 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),

Reference-9: 80-87, 97 to 109.

Aims and Learning objectives: The students are expected to learn

Dyes - Students should know about

i. Dyes: introduction,

ii. Dye intermediates,

iii. Structural features of a dye;

iv. Classification of dyes,

v. Synthesis, Structures, properties and applications of dyes

Pigments: Students should know about

i. Introduction,

ii. Classification and general properties of pigment

iii. Production processes of zinc oxide and iron oxide

References:

1. Industrial Chemistry, B. K. Sharma, Goel publishing House, 18th Ed. (2014)
2. Riegeal's Hand book of industrial chemistry, James A. kent. 9th Ed. CBS publishers
3. Advanced Inorganic Chemistry, Satyaprakash, Tuli, Basu pages 458-463.
4. Advanced Inorganic Chemistry, Satyaprakash, Tuli, Basu pages 830-849
5. Handbook of Industrial Chemistry and Biotechnology, James A. Kent, Tilak V. Bommaraju, Scott D. Barnicki, Thirteenth Edition, Springer.
6. Inorganic Pigments by Gerhard Pfaff, Publisher-De Gruyter, 1st Ed.
7. Shreeve's chemical process industries 5th Edition, G.T. Austin, TATA McGraw-Hill Edition, chemical engineering series
8. Industrial Chemistry, Part-II, R. K. Das, Kalyani Publisher, Second Ed.
9. Inorganic Pigments by Gerhard Pfaff, Publisher-De Gruyter, 1st Ed.

www.wikipedia.org/wiki/copyright_act_of1976 , www.wikipedia.org/wiki/patentact and www.wikipedia.org/wiki/trademark

Industrial visit:

Visit to any one of the Chemical / Pharmaceutical / Polymer / Research Institutes / Sugar Factories / waste water treatment plant, etc. is essential and a systematic report is to be submitted by the student to the Department of Chemistry.

DSEC-II: CH-506: Inorganic Chemistry Practical - I [Credit -2, 73 L]

Total 12 experiments to be completed.

A. Gravimetric estimations (Any 3)

1. Gravimetric estimation of Fe as Fe2O3. Ref-1: 457
2. Gravimetric estimation of Ba as BaSO4 using homogeneous precipitation method. Ref-1: 448
3. Gravimetric estimation of Nickel as Ni – DMG. Ref-1: 462
4. Analysis of sodium bicarbonate from mixture by thermal decomposition method. Ref.-6
5. Determination of water of crystallization by thermal decomposition. Reference-5
6. Analysis of Food/Pharmaceutical sample for ash and sulphated ash example-Aspirin, Ref. -2.

B. Inorganic preparations (Any 3) (Ref-7, 8, 9)

Preparation of inorganic complexes and spot tests for metal ions and ligands:

1. Preparation of hexamminenickel(II) chloride, $[Ni(NH_3)_6]Cl_2$.
2. Preparation of Potassium trioxalatoferrate(III), $K_3[Fe(C_2O_4)_3]$.
3. Preparation of Manganese (III) acetylacetonate, $[Mn(acac)_3]$.
4. Preparation of tris(glycinato)nickelate(II), $[Ni(gly)_3]^-$
5. Preparation of Potassium dioxalatocuprate(II),$[Cu(C_2O_4)_2]^{2-}$.

C. Inorganic Qualitative Analysis (6 Expts.)

1. Inorganic Qualitative analysis (5 mixtures) [1 simple water soluble mixture, 2 mixtures containing borates and 2 mixtures containing phosphates]

(*DST manual green chemistry monograph procedure must be followed strictly*) Ref.-4

2. Limit test for iron, chloride and sulphate from pharmaceutical raw materials. Ref.-2; pp - 220

OR

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). Reference-3

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: Indian Pharmacoepia, Vol-2; 2007

3: Basics of Analytical toxicology, World Health Organization

4: Green Chem - [PDF Document] – FDOCUMENTS; (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.

Structure of Practical Examination [35 Marks; Time: 3 hours]

Q1. Gravimetric estimation/Inorganic preparation/Inorganic Qualitative analysis…. *30 M*

Q2. Viva-Voce ……. *05 M*

DSEC-III: CH-507: Organic Chemistry - I [Credit -2, 36 L]

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Polynuclear and Heteronuclear Aromatic Compounds	08
2	Active Methylene Compounds	05
3	Rearrangement Reactions	12
4	Elimination reactions	11
	Total	**36**

1. Polynuclear and Heteronuclear Aromatic Compounds [08 L]

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.3: Pages 952 – 962. 2.

2. Active Methylene Compounds [05 L]

Definition, Preparation of Ethylacetoacetate and Synthetic uses of ethylacetoacetate Preparation of Diethyl malonate and Synthetic uses of diethyl malonate, (preparation of non-heteromolecules having upto 6 carbon). Ref.1: Pages 864 – 875. Ref.3: Pages 859 – 874. Ref.6: Pp 206 – 213.

3. Rearrangement Reactions [12 L]

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.4: Pages 618-656. Ref.7: Pages 89-94, 105-107, 112-114, 122-125, 158-161. Ref.10: Pages 130-132.

4. Elimination reactions [11 L]

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. 3: Pages 260-265. Ref.4: Pages 472-496. Ref.6: Pages 188-194.

References

1) R.T. Morrison & R.N. Boyd: Organic Chemistry, 7th edition, Prentice Hall.

2) Organic Chemistry: Clayden, Greeves, Wothers, Warren, Oxford Press.

3) Organic Chemistry: Graham Solomans

4) E. S. Gould: Mechanism and Structure in Organic Chemistry

5) Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman

6) I.L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S.

7) S. N. Sanyal: Reactions, Rearrangements and Reagents

8) Eliel: Stereochemistry of Organic Compounds, Tata Mc Graw Hill, 1989

9) D. Nasipuri: Stereochemistry of Organic Compounds- Principles and Applications, New Age International Publishers, 3rd edition.

10) Jagdamba Singh, Jaya Singh: Photochemistry and Pericyclic reactions.3rd edition

Learning Outcomes

Chapter 1 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.

Chapter 2 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

Chapter 3 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

Chapter 4 Elimination Reactions: Students should be familiar with

1. 1,1 and 1,2 elimination
2. E1, E2 and E1cB mechanism with evidences of these reactions 4
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

DSEC-III: CH-508: Chemistry of Biomolecules [Credit -2, 36 L]

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Introduction to molecular logic of life	03
2	Carbohydrates	07
3	Lipids	06
4	Amino acids and Proteins	08
5	Enzymes	06
6	Hormones	06
	Total	**36**

1. Introduction to molecular logic of life. (3L)

Unicellular and multicellular organisms, prokaryotes and eukaryotes. List of cell organelles and its functions. Molecules that constitute the organisation of cell and its organelles. types of bonds in biomolecules

2. Carbohydrates (7L)

Introduction, classification of carbohydrates, their structures and biological significance. Concept of anomers, epimers, reducing and non-reducing sugars, mutarotation, inversion. Reactions of glucose with acid, base, phenyl hydrazine, oxidizing agents, reducing agents and its significance, Glycosidic bonds.

3. Lipids (6L)

Introduction, classification of lipids, their structures and biological significance. Reactions of Lipids-Saponification Hydrolysis, emulsification, oxidation. Concept of saponification number, acid number, iodine number and their significance. Rancidity. Types of Lipoproteins and their significance. Blood group substances.

4. Amino acids and Proteins (8L)

Amino acids: classification of amino acids. Cocept of ampholytes, isoelectric pH, zwitter ions, titration curve of glycine. Reactions of amino acid with Ninhydrin, Sanger's, Dansyl chloride, Dabsyl chloride and Edmann's reagents and their significance. Peptide bond and its features. **Proteins:** Classification based on function, nutrition and composition. Structural organization of proteins- primary, secondary, tertiary and quaternary structures.

5. Enzymes (6L)

Classification of enzymes. Features of active site. ES complex formation, Enzyme specificity, Factors affecting enzyme activity. Basics of Enzyme kinetics. MM and LB equation and

Significance of Km. Types of Enzyme inhibitions. Concept of Conjugated enzymes- Holoenzyme, Apoenzyme, prosthetic groups. Coenzymes of vitamins. Industrial applications of enzymes.

6. Hormones (6L)

Introduction to endocrine glands and their hormones. Biochemical nature of hormones, Mechanism of action of lipophilic and hydrophilic hormones.

References

1. Lehninger's Principles of Biochemistry, by Nelson and Cox Macmillan Publisher 4th Edn.
2. Biochemistry by U. Satyanarayana
3. Harper's Illustrated Biochemistry, 26th Edition
4. Biophysical techniques by Upadhyay and Nath, 3rd revised edition.
5. Organic Chemistry, Morrison, R. T. & Boyd, R. N.
6. Organic Chemistry (Volume 1) Finar, I. L.
7. Organic Chemistry (Volume 2) Finar, I. L.

Learning Outcome:

1. **Introduction to molecular logic of life.** The student will understanding of Cell types, Difference between a bacterial cell, Plant cell and animal cell. Biological composition and organization of cell membrane, structure and function of various cell organelles of plant and animal cell. Concepts of biomolecules, Bonds that link monomeric units to form macromolecules
2. **Carbohydrates:** The student will understand the types of carbohydrates and their biochemical significance in living organisms, structure of carbohydrates and reactions of carbohydrates with Glucose as example. Properties of carbohydrates.
3. **Lipids:** The student needs to know the types of lipids with examples, structure of lipids, properties of lipids
4. **Amino acids and proteins:** The student will understand the structure and types of amino acids. Reactions of amino acids. Properties of amino acids. Peptide bond formation. Types of proteins. Structural features in proteins. Effect of pH on structure of amino acid, Determination of N and C terminus of peptide chain.
5. **Enzymes:** The student know the classes of enzymes with subclasses and examples. Enzyme specificity, Equations of enzyme kinetics Km and its significance, features of various types of enzyme inhibitions, industrial applications of enzymes.

6. **Hormones:** Basic concepts of Endocrinology. Types of Endocrine glands and their hormones. Biochemical nature of hormones. Mechanism of action of lipophilic and hydrophilic hormones.

DSEC-III: CH-509: Organic Chemistry Practical-I [Credit -2, 73 L]

Total 12 Experiments to be performed

A) Separation of Binary Mixtures and Qualitative Analysis (Any Six)

a) Solid-Solid (3 Mixtures) b) Solid-Liquid (2 Mixtures) c) Liquid-Liquid (1 Mixture) At least one mixture from each of the following should be given-Acid-Base, Acid- Phenol, AcidNeutral, Phenol-Base, Phenol-Neutral, Base-Neutral and Neutral- Neutral. (Solid-solid mixtures must be insoluble in water)

B) Preparations

a) Green Chemistry Preparations (Any Two)

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)

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)

1. Amide derivative of Carboxylic acid
2. Glucosazone derivative of Glucose
3. Paracetamol from p-Aminophenol

Imp. Note: At the time of practical examination candidate should perform complete analysis of one binary mixture OR One preparation and one preparation of organic derivative.

• To develop skills required in chemistry such as the appropriate handling of apparatus and chemicals.

• The student will learn the laboratory skills needed to design, safely conduct and interpret chemical research.

• To expose the students to an extent of experimental techniques using modern instrumentation.

• The student will develop the ability to effectively communicate scientific information and research results in written and oral formats.

Learning Outcomes:

A) Separation of Binary Mixtures and Qualitative Analysis The students will be able to

1. Perform the quantitative chemical analysis of binary mixture, explain principles behind it.
2. Separate, purify and analyse binary water insoluble mixture.
3. Separate, purify and analyse binary water-soluble mixture.
4. Understand the techniques involving drying and recrystallization by various method.
5. Familiarize the test involving identification of special elements.
6. Learn the confirmatory test for various functional groups.

B) Preparations The students will be able to

1. Systematic working skill in laboratory will be imparted in student.
2. Learn the basic principles of green and sustainable chemistry.
3. Synthesis of various organic compounds through greener approach.
4. Do and understand stoichiometric calculations and relate them to green process metrics.
5. Learn alternative solvent media and energy sources for chemical processes.
6. Learn the preparations of derivative various functional groups aspects of electrical experiments.
7. Understand the techniques involving drying and recrystallization by various method
8. Expertise the various techniques of preparation and analysis of organic substances
9. Understand principle of Thin Layer Chromatographic techniques.
10. Understand the purification technique used in organic chemistry.

SEC-I: CH-510: Skills Enhancing Course-I [Credit -2, 36 L]

Choose one out of the two options, A and B.

CH-510 (A) : Introduction to Medicinal Chemistry

Chapter No.	Title	Number of Lectures
1	An Introduction to Drugs, their Action and Immunobiologicals	08
2	Bio-physicochemical Properties in Drug Action and Design	08
3	Drugs for Infectious Diseases	12
4	Drugs for Non -infectious Diseases	08
	Total	**36**

1. An Introduction to Drugs, their Action and Immunobiologicals (8L)

A. Introduction, Need of new drugs, Historical background of drug discovery and design, Sources of drugs, Classification of drugs, Introduction to drug action

(*Ref.1 Pages 37-53, Ref.2 Pages 4-11, Ref.4 Pages 4-9*)

B. Immunobiologicals: Vaccines: Introduction, Methods of vaccine production: Inactivated pathogens, Live/Attenuated Pathogens and Cellular Antigen from a pathogen, SARS-CoV-19

(*Ref.3 Pages 165-168, Ref.9, Ref.10*)

2. Bio-physicochemical Properties in Drug Action and Design (8L)

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*)

3. Drugs for Infectious Diseases (12L)

Introduction, Structures, Mode of Action and Applications**:**

A. Antimicrobial Agents: Classification on i) Type of action: Bacteriostatic and Bactericidal ii) Source (Natural, Synthetic and Semisynthetic) iii) Spectrum of activity: Narrow and Broad Spectrum iv) Chemical structure: β-lactams (Penicillin), Macrolides (Azithromycin), Sulphonamides (Sulfadiazine), and Tetracyclins (Chlortetracycline)

B. Anti-fungal and anti-viral agents: Example: Amphotericin-B, Acyclovir

(*Ref.1 Pages 131-157, Ref.2 Pages 413-472, Ref.3 Pages 258-308, Ref.4 Pages 191-228*)

4. Drugs for Non-infectious diseases (8L)

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 Pp 443-457, 509-515,637-647, 776-792, Ref. 5, Ref.6, Ref.7, Ref. 8 Pp.69-70,481-491*)

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. Medicinal chemistry, fourth edition, Ashutosh Kar (2007).
6. Metallodrugs in Medicinal Inorganic Chemistry Katja Dralle Mjos and Chris Orvig, Chem. Rev. 2014, 114, 4540-4563, http://dx.doi.org/10.1021/cr400460s
7. 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.
8. Metallo-therapeutic Drugs And Metal-Based Diagnostic Agents by Marcel Gielen and Edward R.T. Tiekink
9. 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
10. 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

Learning Outcomes:

Upon completion of the course the student shall be able to understand,

1. 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.

Additional Study Material: NPTEL Video lecture on Medicinal Chemistry:

1. https://youtu.be/UHEXXGiegd0 ;
2. https://youtu.be/rVN_HybZ-Vk
3. https://youtu.be/-fCXLW-jF2o
4. https://youtu.be/n5C-peu54Wk
5. https://youtu.be/0wx4hep1low
6. https://youtu.be/9lWrNuUzP4A
7. https://youtu.be/84-q3SAVEQk

CH-510 (B) : Polymer Chemistry

Chapter No	Topic	Number of lectures
1	Introduction and history of polymeric materials	6
2	Polymerization Chemistry	12
3	Molecular weight of Polymers	6
4	Important Polymers	12
	Total	**36**

1. Introduction and history of polymeric materials: (6 L)

Brief history, Basic terms- monomer, polymer, polymerisation, degree of polymerisation, functionality. Different schemes of classification of polymers, polymer nomenclature, molecular forces and chemical bonding in polymers, glass transition temperature of polymer.

Ref. 1: Pages 1-20, 150

Ref. 2: Pages 1-16

Ref. 5, 7 & 8 Relevant Pages

2. Polymerization Chemistry (12 L)

Classification of polymerization processes, mechanism of- step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations. Polymerization techniques-bulk, solution, suspension, emulsion and interfacial condensation.

Ref. 1: Pages 20-58, 71-79

Ref. 2: Pages 25-32, 49-56, 82-86, 88-94, 126-132

Ref. 3 & 4 Relevant Pages

3. Molecular weight of Polymers (6 L)

Average molecular weight of polymer, Number average molecular weight (M_n), Weight average molecular weight (M_w), Number average molecular weight by end group analysis, Viscosity average molecular weight by viscometric method, klMolecular weight distribution and its significance, polydispersity index.

Ref. 1: Pages 86-98, 402-409

Ref. 2 & 4: Relevant Pages

4. Important Polymers: (12 L)

Brief introduction to preparation, structure, properties and application of the following polymers: polyethylene, polystyrene, polyvinyl chloride, polyvinyl alcohol, polymethyl methacrylate, polytetrafluoroethylene, polyamides, polyesters, phenol formaldehyde resins (Bakelite, Novolac), silicone polymers, polyisoprene, conducting Polymers.

Ref. 1: Pages 215-255

Ref. 3, 4 & 6 Relevant Pages

Course Outcome: The students are expected to learn the following aspects of Polymer Chemistry:

1) History of polymers.

2) Difference between simple compounds and polymer.

3) Names of polymers.

4) Various ways of nomenclature.

5) Difference between natural, synthetic, organic and inorganic polymers.

6) Terms-Monomer, Polymer, Polymerization, Degree of polymerization, Functionality, Number average, Weight average molecular weight.

7) Mechanisms of polymerization.

8) Polymerization techniques.

9) Uses & properties of polymers.

10) Role of polymer industry in the economy.

11) Advantages of polymers.

Reference Books:

1. Polymer Science by V.R. Gowarikar, N.V.Vishvanathan, JaydevShreedhar New Age International Ltd. Publisher 1996. (Reprint 2012)
2. Textbook of Polymer Science by Fred Billmeyer, 3rd Edn. A Wiely-Interscience Publication John Wiley& Sons New York 1984. (Reprint 2008)
3. Introductory Polymer Chemistry by G.S.Misra New Age International (P) Ltd. Publisher 1996.
4. Polymer Chemistry by Charles E. Carraher (Jr.), 6th Edn, (First Indian Print 2005), New York- Basel.
5. Principle of Polymer Science by P. Bahadur, N.V. Sastry, 2nd Edn, Narosa Publishing House.
6. Polymer Chemistry by Ayodhya Singh, 2008, Published by Campus Book International, New Delhi.
7. Organic Polymer Chemistry by Jagdamba Singh, R.C. Dubey, 4th Edn, 2012.
8. Principles of Polymerisation by George Odian3rd Edn. John Wiley & Sons New York.

SEC-II: CH-511: Skills Enhancing Course-II [Credit -2, 36 L]

Choose one out of the two options, A and B.

CH-511 (A) : Environmental Chemistry

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Concepts and Scope of Environmental Chemistry	06
2	Hydrosphere and Water Pollution	10
3	Analytical Techniques in water Analysis	10
4	Water pollution and treatment methods	10
	Total	**36**

1: Concepts and Scope of Environmental Chemistry (06L)

Introduction, Environmental Pollution and Classification, Units of concentration, Segments of Environment, Biogeochemical cycles of C, N, P, S and O system

Reference: 1, 2, 3

Aims and objectives: -Students should know:

i. Importance and conservation of environment.

ii. Importance of biogeochemical cycles

2: Hydrosphere and Water Pollution (10L)

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, Sampling and monitoring water quality parameters: pH, D.O. (Winkler Method), COD, TOC, Total hardness, free chlorine.

Reference: 1 Page no -47-62,

Aims and Objectives:- Students should know:

i. Water resources

ii. Hydrological Cycle

iii. Organic and inorganic pollutants

iv. Water quality parameters

3. Analytical Techniques in water Analysis (10 L)

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, Sulfide, sulphate, phosphate, total hardness, boron, metals and metalloids- As, Cd,

Cr, Cu, Fe, Pb, Mn, Hg (Exclude polarographic and AAS methods), COD, BOD, TOC, phenols, pesticides, surfactants, tannis and lignins, E. Coli, Case studies of water pollution.

Ref-1: 225-278

4. Water pollution and treatment methods (10 L)

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 (Cu, Pb, Hg, As, Se, Cr)

Ref-1: 167-225

Reference-1: Environmental Chemistry – A. K. De, Third Edition (Wiley)

Additional References:

1. Environmental Chemistry – A. K. De, 5th Edition (New age international publishers)
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 – J. W. Moore and E. A. Moore (Academic Press, New York)
5. Basic Concepts of Analytical Chemistry: S. M. Khopkar, Wiley Eastern (1995)

CH-511 (B) : Cheminformatics

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Introduction to Cheminformatics	02
2	Representation of Molecules and Chemical Reactions	10
3	Searching Chemical Structures	06
4	Applications of Cheminformatics	18
	Total	**36**

1. Introduction to Cheminformatics [02L]

1.1. History and progression of cheminformatics

1.2. Significance of cheminformatics

1.3. Prospects of cheminformatics and Molecular Modelling

Learning Outcomes:

1. Students should understand the significance of cheminformatics in the modern practices of chemical science
2. Students should learn the necessity of cheminformatics in chemical science

Ref. 2. (Page no. 4-11 and relevant pages)

2. Representation of Molecules and Chemical Reactions: [10L]

2.1. Nomenclature

2.2. Different types of notations

2.3. Canonical representation of chemical structure, SMILES notation

2.4. 2D representation of chemical structure; Graph Theory, Connection tables and linear notations, Matrix representations

2.5. 3D chemical structure representation and molecular structure file formats; Molfiles, Sdfiles and Pdbfiles

2.6. 3D molecular structure visualization

2.7. Chemical Libraries (Pubchem, ChEMBL, DrugBank and Zinc) and online Available cheminformatics toolkits

2.8. Molecular properties calculations; electronic effects, Reaction classification

Learning Outcomes:

1. Students should learn the basic concepts about these representation methods.
2. Students should understand the significance of different representation methods for their specific applications.
3. Students should able to identify these representation methods with understanding.
4. Students should able to read these representation methods for basic examples.

Ref. 1. (Page no. 1-74, 183-201 and relevant pages)

Ref. 2. (Page no. 15-51, 92-96, 169-197 and relevant pages)

3. Searching Chemical Structures: [06L]

3.1. Basic ideas about the Full structure search, Sub-structure search

3.2. Basics of similarity and diversity search; Tanimoto, Dice, Cosine coefficient and Euclidean distance

3.3. Basics of three dimensional search methods

3.4. Basics of computation of physical and chemical data and structure descriptors.

Learning Outcomes:

1. Students should learn the basic concepts of referencing
2. Students should understand the significance of structural data in the process of referencing
3. Students should able to correlate the necessity of input methods and the expected outcomes for the set of chemicals
4. Students should able to understand data interpretation using these methods for basic or representative molecules.

Ref. 1. (Page no. 141-158 and relevant pages)

Ref. 2. (Page no. 291-313, 320-431 and relevant pages)

Ref. 3. (Page no. 39-50, 317-371 and relevant pages)

4: Applications of Cheminformatics: [18 L]

4.1. Prediction of Properties of Compounds: Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Model Building; Modeling Toxicity

4.2. Predictive Methods for Organic Spectral Data Simulation: Spectra prediction methods and tools, open source and propriety tools, spectra viewer programs, Structure-Spectra correlations

4.3. Introduction to computer aided drug design: Computer Assisted Synthesis Design; Target Identification and Validation; Lead Finding and Optimization; Combinatorial library design, Virtual screening, Molecular docking and Molecular Dynamics simulation. Pharmacophore modeling; Ligand-Based and Structure Based virtual screening, Drug likeness properties, Protein Ligand Interaction Profile (PLIP) analysis and its application in drug discovery process

4.4. Machine Learning Methods in Cheminformatics

4.5. Introduction to Cheminformatics Softwares: Basic operational principle and applications of MarvinSketch, Discovery Studio, Gaussian, GOLD, Schrodinger, Expert protein Analysis System (Expasy) online server

Learning Outcomes:

1. Students should learn the basic idea about how to apply cheminformatics tool for variety of applications.
2. Students should understand the significance of database for the specific purpose of application.
3. Students should able to correlate the content of data with the possible applications for the set of chemicals.
4. Students should get aware with the principle and the basic operational methods of well-practiced software used in the data interpretation in cheminformatics.
5. Students should learn the basic concepts of Machine Learning and Artificial intelligence

Ref. 1. (Page no. 75-97 and relevant pages)

Ref. 2. (Page no. 487-542, 567-616 and relevant pages)

Ref. 3. (Page no. 10-15, 93-129, 133-192, 375-406 and relevant pages)

Reference Books:

1. Andrew R. Leach and Valerie, J. Gillette (2007) An introduction to Chemoinformatics. Springer: The Netherlands.
2. Gasteiger, J. and Engel, T. (2003) Chemoinformatics: A text-book. Wiley-VCH.
3. Muthukumarasamy Karthikeyan and Renu Vyas (2014) Practical Chemoinformatics, Springer

Semester-VI

DSEC-IV: CH-601 : Physical Chemistry-II [Credit -2, 36 L]

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Electrochemical Cells	16
2	Crystal structure	10
3	Nuclear Chemistry	10
	Total	**36**

1. Electrochemical Cells [16 L]

Electrochemical cells, 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, 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. (iii) Precipitation titration, 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

Expected learning Outcomes:

After studying this chapter, the student will be able to know and understand:

1. Electrochemical cells: Explanation of Daniell 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
13. 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
14. Primary Batteries: Dry Cells, alkaline batteries with respect to construction, diagram and working
15. Secondary Batteries: Nickel-cadmium, Lithium-ion batteries, the lead acid battery with respect to construction, diagram and working
16. Applications for Secondary Batteries
17. Fuel Cells: Types of fuel cells, advantages, disadvantages of these fuels cells, comparison of battery Vs fuel cell
18. Problems

Reference books:

1. Essential of Physical Chemistry, Bahl and Tuli (S. Chand)., (Page No: 1154-1178)
2. Principles of Physical Chemistry by Puri, Sharma, Pathania, (Page No: 835-880)
3. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000, (Page No: 320-412)
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, (Page No: 1789-1888)

2. Crystal structure [10 L]

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: Three 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.

Expected learning Outcomes:

After studying this topic students are expected to know and understand:

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. Methods of Crystal structure analysis: The Laue method and Braggs method: 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. Problems

Reference books:

1. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).,(Pp: 491-507, 518-528)
2. Principles of Physical Chemistry by Puri, Sharma, Pathania, (Page No: 1165-1180)

3. Nuclear Chemistry [10L]

Radioactivity, Types of Radiations, Properties of Radiations, Detection and Measurement of Radioactivity: Cloud chamber, Ionization Chamber, Geiger-Muller Counter, Scintillation Counter and Film Badges, Nuclear structure, Classification of nuclides, Types of Radioactive Decay, The Group Displacement 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 C^{14} dating, Problems

Expected learning Outcomes:

After studying this topic students are expected to know

1. 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 PCl_5, Age determination use of tritium and C^{14} dating.
9. Solve the problems based on this topic

Reference books:

1. Elements of Nuclear Chemistry by H.J. Arnikar
2. Essential of Physical Chemistry, Bahl and Tuli (S. Chand)., (Page No: 117-145)

Additional Reference Books:

1) Physical Chemistry by G. M. Barrow, International student Edition, Mc Graw Hill.
2) University General Chemistry by C.N.R. Rao, Macmillan.
3) Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
4) The Elements of Physical Chemistry by P. W. Atkins, Oxford.
5) Principles of Physical Chemistry by S. H. Maron, C. H. Prutton, 4thE dition.
6) Principles of Physical Chemistry by Puri, Sharma, Pathania,
7) Chemical applications of radioisotopes by H.J.M. Brown
8) Source book of Atomic energy by S. Glasstone and D. Van .
9) 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, Kluwer Academic Publishers New York, Boston, Dordrecht, London, Moscow

DSEC-IV: CH-602 : Physical Chemistry-III [Credit -2, 36 L]

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Colligative properties of dilute solutions	09
2	Kinetics of Reactions in the Solid State	09
3	Electronic structure and macroscopic properties	08
4	Polymers	10
	Total	**36**

1) Colligative properties of dilute solutions (09L)

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, Numerical.

Expected learning Outcomes:

After studying this topic students are expected to know

1. Meaning of the terms-Solution, electrolytes, nonelectrolytes and colligative properties,
2. Lowering of vapour pressure of solvent in solution,
3. Elevation of B.P. of solvent in solution, Landsberger's method,
4. freezing point depression, Beckmann's method Osmosis and Osmotic pressure, Berkeley and Hartley method,
5. Application of colligative properties to determine molecular weight of nonelectrolyte, abnormal molecular weight,
6. Relation between Vant Hoff's factor and degree of dissociation of electrolyte by colligative property,
7. Problems.

Reference books:

3) Principles of Physical Chemistry by Puri, Sharma, Pathania, (Page No: 778 - 800)
4) Essential of Physical Chemistry, Bahl and Tuli (S. Chand). (Page No: 614 - 684)

2) Kinetics of Reactions in the Solid State: (09L)

Some General Considerations, Factors affecting reactions in Solids, Rate Laws for Reactions in Solids , The Parabolic Rate Law, The First-Order Rate Law, The Contracting Sphere Rate Law, The Contracting Area Rate Law, The Prout–Tompkins Equation, Rate Laws Based on Nucleation, Applying Rate Laws, Results of Some Kinetic Studies, The Deaquation-Anation of $[Co(NH_3)_5H_2O]Cl_3$, Two Reacting Solids

Expected learning Outcomes:

1. Factors affecting on solid state reactions,

2. Rate laws for reactions in solid state

3. Applying rate laws for solid state reactions

4. Results of kinetics studies

Reference books:

1) Principles of James E House, Second Edn, (Page nos: 229 to 262)
2) Principles of Physical Chemistry by Puri, Sharma, Pathania,
3)Essential of Physical Chemistry, Bahl and Tuli (S. Chand).

3) Electronic structure and macroscopic properties (08L)

Cohesive energy in ionic crystals, electronic structure of solids, conductors and insulators, Ionic crystals, semiconductors, cohesive energy in metals.

Reference books:

1. Castellan, G.W. Physical Chemistry Third edition (1993) , Addision –Wesley Publishing Co. (Page Numbers 709-719)

Expected learning Outcomes:

1. Cohesive Energy of ionic crystals based on coulomb's law and Born Haber Cycle
2. Correspondence between energy levels in the atom and energy bands in solid
3. Band structure in solids – Na , Ca and diamond
4. Conductors and insulators – Its correlation with Extent of energy in energy bands
5. phenomena of photoconductivity
6. Semiconductors – Role of impurity in transformation of insulator into semiconductor
7. Temperature dependant conductivity semiconductors
8. Cohesive Energy in metals
9. Numericals based on cohesive energy

4) Polymers (10L)

Introduction to Polymer Chemistry, Brief History, Polymer definition, Preparation, Classification, Structures, Chemical bonding & Molecular forces in Polymers. Ref. 1: Pages 1-14, Ref. 2: Pp. 1-16

Molecular weights of polymers: Average Molecular weight, Number Average & Weight Average Molecular weight, Molecular weight & degree of polymerisation, Practical significance of polymer molecular weights, b) Molecular weight determination by End Group Analysis & Viscosity method and c) Problems based on Number Average & Weight Average Molecular weight Ref. 1: Pages 86-89, 92, 96-98, 402-409

References

Polymer Science by V.R. Gowarikar, N.V. Vishvanathan, Jaydev Shreedhar New Age International Ltd. Publisher 1996.(Reprint 2012)

Textbook of Polymer Science by Fred Billmeyer, 3rd Edn. A Wiely-Interscience Publication John Wiely& Sons New York 1984. (Reprint 2008)

Expected learning Outcomes:

After studying this topic students are expected to know

1) History of polymers.
2) Classification of polymers
3) Chemical bonding & Molecular forces in Polymer
4) Molecular weight of polymers
5) Practical significance of polymer molecular weights
6) Molecular weight determination

Reference books:

1) Essential of Physical Chemistry, Bahl and Tuli (S. Chand). (Page No: 1 - 35)
2) Principles of Physical Chemistry by Puri, Sharma, Pathania, (Page No: 9-23)

Other Reference Books:

1. Atkins' Physical Chemistry by Peter Atkins Professor of Chemistry, University of Oxford, and Fellow of Lincoln College, Oxford Julio de Paula Professor and Dean of the College of Arts and Sciences Lewis and Clark College, Portland, Oregon
2. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).

DSEC-IV: CH-603 : Physical Chemistry Practical-II [Credit -2, 73 L]

Total 12 Experiments to be performed.

1. Potentiometry (any five)

1) To determine the PKa value of given monobasic weak acid by potentiometric titration.
2) To determine the formal redox potential of Fe_2+/ Fe_3+ system potentiometrically.
3) To determine the amount of NaCl in the given solution by potentiometric titration against silver nitrate.
4) To determine the solubility product and solubility of AgCl potentiometrically using chemical cell.
5) Estimate the amount of Cl-, Br- and I- in given unknown halide mixture by titrating it against standard AgNO3 solution (mixture of any two ions).
6) To prepare standard 0.2 M Na2HPO4 and 0.1 M Citric acid solution, hence prepare four different buffer solutions using them. Determine the pH value of these and unknown solution.

7) To determine the composition of Zinc ferrocyanide complex potentiometrically
8) To determine the standard electrode potentials of Cu and Ag electrodes and to determine the EMF of a concentration cell.

2. pH metry (any three)

1) To determine the degree of hydrolysis of aniline hydrochloride.
2) To determine the dissociation constant of oxalic acid by pH-metric titration with strong base.
3) Determination of Pka of given weak acid by pH metry titration with strong base
4) To determine the acid and base dissociation constant of an amino acid and hence the isoelectric point of an acid.
5) pH metric titration of strong acid against strong base by pH measurement and hence determine the concentration and strength of strong acid.

3. Radioactivity (any one)

1) To determine plateau voltage of the given G M counter.
2) To determine the resolving time of GM counter.
3) To determine Emax of beta particle

4. Colligative properties (any one)

1. To determine the molecular weight of solute by depression in freezing point method
2. To study the association of Benzoic acid in benzene by Beckmann Method
3. Determine the molecular weight of given electrolyte and non-electrolyte by Landsberger's method and to study the abnormal molecular weight of electrolyte

5. Turbidometry: (any one)

1. Determination of $SO4^{2-}$ and Cl^{-} by turbidimetric method (turbidimetric titration or calibration curve method)
2. To determine the molecular weight of a given polymer by turbidometry

6. Table work

1.Analysis of crystal structure from X-ray diffraction spectra of any two compounds (Calculation d, lattice constant, crystal volume and density, and assigning planes to peaks using JCPDS data)

Reference Books:

1. Practical physical chemistry, A. Findlay, T.A. Kitchner (Longmans, Green and Co.)
2. Experiments in Physical Chemistry, J.M. Wilson, K.J. Newcombe, A.r. Denko. R.M.W. Richett (Pergamon Press)
3. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Garg (R. Chand and Co.,

Delhi.).

4. Experimental Physical Chemistry by D. P. Shoemaker, Mc. Growhill, 7th Edition, 2003.
5. Physical chemistry by Wien (2001)
6. Advance Physical Chemistry Experiment, Gurtu and Gurtu, Pragati Publication (Meerut),
7. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publishing House
8. Practical physical Chemistry, B. Vishwanathan and P. S. Raghwan, Viva Books
9. Vogel-qualitative-inorganic-analysis-5th-edition-1979
10. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.
11. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

DSEC-V: CH-604 : Inorganic Chemistry -II [Credit -2, 36 L]

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Organometallic Chemistry	08
2	Homogeneous and Heterogeneous catalysis	10
3	Bioinorganic Chemistry	08
4	Inorganic Polymers	05
5	Inorganic solids/ionic liquids of technological importance	05
	Total	**36**

1. Organometallic Chemistry [8L]

Definition of Organometallic compounds and Organometallic chemistry, 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.]

Aim and Objectives: Students should be able:

i. To understand M-C bond and to define organometallic compounds
ii. To define organometallic chemistry
iii. To understand the multiple bonding due to CO ligand.
iv. To know methods of synthesis of binary metal carbonyls.
v. To understand the structure and bonding using valence electron count (18 ele. rule)
vi. To understand the catalytic properties of binary metal carbonyls.
vii. To understand the uses of organometallic compounds in the homogenous catalysis.
viii. Chemistry of ferrocene

References:

1. Inorganic Chemistry – D.F. Shriver, P.W. Atkins, C.H. Lamgford – Oxoford, 5th Edn., 1994, pp 534-542,553-564.
2. Concise Inorganic Chemistry by J. D. Lee (Relevant pages)
3. General Chemistry by Raymond Chang(Relevant pages)

4. Basic Organometallic Chemistry: Concepts, Syntheses and Applications of Transition Metals (CRC), B. D. Gupta and Anil J. Elias, Universities Press; 2nd Edition, 2013.

2. Homogeneous and Heterogeneous catalysis [10L]

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. **[References 1 to 3]**

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. **[Reference 5 to 6]**

[Further reading: Student should also read about advanced development in the field of homogeneous and heterogeneous Catalysis.]

Aims and objectives: A student should be able to:

i. Understand the phenomenon of catalysis, its basic principles and terminologies.
ii. Define and differentiate homogeneous and heterogeneous catalysis.
iii. Give examples and brief account of homogeneous catalysts.
iv. Understand the essential properties of homogeneous catalysts-Give the catalytic reactions for Wilkinson's Catalysis, hydroformylation reaction, Monsanto acetic acid synthesis, Heck reaction
v. Understand the principle of heterogeneous catalyst and development in it.
vi. Give examples of heterogeneous catalysts.
vii. Understand the classification and essential properties of heterogeneous catalysts.
viii. Give the brief account of Hydrogenation of olefins , Zeolites in catalysis, biodiesel synthesis, Automotive Exhaust catalysts
ix. Understand the catalytic reactions used in industries around.

References:

1. Homogeneous Catalysis: The Applications and Chemistry of Catalysis by Soluble Transition Metal Complexes, G.W. Parshall and S.D. Ittel, Wiley, New York 1992.

2. Inorganic Chemistry D.F. Shriver and P.W. Atkins, 5th Edn, Oxford University Press, 2010, Chapter 26 pp690-721.
3. Homogeneous Catalysis: Mechanisms and Industrial Applications, S. Bhaduri and D. Mukesh, Wiley, New York, 2000.pp 13-23, 55-61,85-102, 161-163
4. Catalysis: Concepts and Green Applications: Gadi Rothenberg, Wiley-VCH; First edition, 2015 Relevant pages.
5. Heterogeneous catalysis in industrial practice, Chaerls N. Shatterfield, second edition, Krieger Publishing Company, Florida USA pp 1-16, 87-112, 203-205, 222-224.
6. Heterogeneous catalysis by B. Vishwanathan and D. K. Chakrabarty , New Age International Private Limited, 2007 (Relevant pages)

3. Bioinorganic Chemistry [8 L]

I. Introduction, Role of metals in bioinorganic chemistry, Classification as enzymatic and non-enzymatic 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, Fe_2S_2, Fe_3S_4, Fe_4S_4). Transport protein (transferrin) and Storage protein (ferritin) III. Bioinorganic Chemistry of Fe: Hemoglobin and myoglobin, its structure and functions and IV. Bioinorganic Chemistry of Co: Vitamin-B_{12}, 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.]

Aims and objective- A student should:

i. Identify the biological role of inorganic ions & compounds.
ii. Know the abundance of elements in living system and earth crust.
iii. Give the classification of metals as enzymatic and non-enzymatic.
iv. Understand the role of metals in non-enzymatic processes.
v. Know the metalloproteins of iron.
vi. Explain the functions of hemoglobin and myoglobin in O_2 transport and storage.
vii. Understand the toxicity of CN- and CO binding to Hb.
viii. Draw the structure of Vit.B_{12} and give its metabolism.

References:

1. Concise Inorganic Chemistry by J.D. Lee - 5th edition, Pages 353, 775, 779, 796-797.
2. Inorganic Chemistry,-D.F. Shiver & P.W. Atkins- C.H. Longford ELBS- 2nd Ed,782-806.

3. Principles of Bioinorganic Chemistry by S. J. Lippard and J. M. Berg, Panima Publishing Corporation, 1st Edn., Pages 1-13, 24, 285-290.

4. Inorganic Polymers [5L]

Introduction, Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicates, silicones, siloxanes, borazines, and phosphazenes.

Aims and objective: A student should be able to:

i. know thy types of Inorganic polymers
ii. comparison with organic polymers
iii. synthesis, structural aspects of Inorganic polymers
iv. understand the polymers of Si, B, Si and P
v. Inorganic polymers and their use.

References:

1. Inorganic polymer chemistry, Pimpalpure , jain, soni, Sahai, Pragati edition 2012, pages 1-7, 110-129, 179-186, 207-217
2. N. H. Ray, Inorganic Polymers, Academic Press (1978).
3. Inorganic Polymers, Second Edition James E. Mark Harry R. Allcock Robert West Oxford University Press, 2nd Edition, 2005.

5. Inorganic solids/ionic liquids of technological importance [5L]

Inorganic solids, Preparation of inorganic solids: Conventional heat and beat methods, Co-precipitation method, Sol-gel method and Hydro-thermal method. Introduction to Solid electrolytes, inorganic liquid crystals and their examples. Ionic liquids, synthesis and application of imidazolium and phosphonium based ionic liquids.

Further reading: student should also read about the advanced smart materials and green aspects of ionic liquids.

Aims and objective: A student should know:

i. Understand Preparation of inorganic solids by various methods,
ii. Inorganic liquid crystals
iii. Ionic liquids, their preparations, and their significance w.r.t green chemistry.
iv. Technological importance of ionic liquids,

Reference

1. Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning, 2002.
2. Ionic Liquids: Industrial Applications for Green Chemistry, Robin D. Rogers, Kenneth R. Seddon, American Chemical Society, Washington, DC, USA.pp1-13, 30-41

DSEC-V: CH-605: Inorganic Chemistry -III [Credit -2, 36 L]

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Acid–Base and Donor–Acceptor Chemistry	08
2	Ionic Solids	10
3	Chemistry of Zeolites	08
4	Introduction to Nanochemistry	05
5	Chemical Toxicology	05
	Total	**36**

1. Acid–Base and Donor–Acceptor Chemistry [8 L]

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).

Aims and objectives: A student should:

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.

Reference: Inorganic chemistry, Gary L Messler and Donald A Tar, Third Ed, Pearson publisher, pages: 67-178, 183 – 208.

2. Ionic Solids [10L]

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.

A student should:

1. Know the nature of solids.
2. Know the crystal structures of solids.

3. Draw the simple cubic, BCC and FCC structures.
4. Identify the C.N. of an ion in ionic solid.
5. Identify the type of void.
6. Know the effect of radius ratio in determining the crystal structure.
7. Be able to define Pauling's univalent radius and crystal radius.
8. Be able to solve simple problems based on Pauling's univalent radii and crystal radii.
9. Know how to draw Born-Haber cycle.
10. Be able to solve simple problems based on Born- Haber cycle.
11. Know the defects in Ionic solids.
12. Be able to differentiate between the defects.

Reference Books:

Ref. 1- Concise Inorganic Chemistry by J.D. Lee - 5th edition. Pages 32-61

Ref .2- Concept and Model of Inorganic Chemistry by Douglas–Mc Daniels - 3rd edition Pp 102-127.

Ref. 3 -New Guide to Modern Valence Theory by G.I. Brown - 3rd edition Pages 55-62

3. Chemistry of Zeolites [8L]

1. Historical Background, Natural and artificial Zeolites,

2. Zeolite Framework Types: Classification, Nomenclature, Database of Zeolite Structures, Channels, Building Units, Natural Tiles, Framework Density, Coordination Sequences

3. Zeolite Structures: Framework Composition, Extra-framework Species, Stacking Faults and Disorder

4. Synthesis of Zeolites: Introduction, Basic Zeolite Synthesis, Mineralizing Agents, Effects of water concentration, Gel preparation and crystallization, Structure Directing Agents (SDA)

5. Applications 1.Zeolites as Heterogeneous Catalysts: Critical Properties for Catalysis, Catalytic Applications, Zeolites for Fine Chemistry: Acylation and Alkylation Aromatic Hydrocarbons, 2. Zeolites for Adsorption and Separations

A student should:

1. Different Zeolite Framework Types and their classification
2. Zeolite synthesis and their structure
3. Application of zeolites

Reference:

1. Zeolites in Catalysis Properties and Applications Edited by Jiri Cejka, Russell E. Morris, Petr Nachtigall, The Royal Society of Chemistry 2017 pp 1-5, 19-25, 37-50, 73-79, 87, 412-414, 418

2. Chemistry of Zeolites and Related Porous Materials: Synthesis and Structure, Ruren Xu, Wenqin Pang, Jihong Yu, Qisheng Huo, Jiesheng Chen, John Wiley & Sons (Asia) Pvt. Ltd, 2007

4. Introduction to Nanochemistry [5L]

Synthesis and Stabilization of Nanoparticles by Chemical Reduction, Reactions in Micelles, Emulsions, and Dendrimers. Photochemical and Radiation Chemical Reduction, Cryochemical Synthesis, Physical Methods. Particles of Various Shapes and Films, Properties and Application of Nanoparticles in Science and Technology (in bief), Applications of CNTs

Reference:

1. Nanochemistry, G.B.Sergeev, Elsevier, 2006, pp 7-36, 175-83,199-201
2. The Chemistry of Nanomaterials C. N. R. Rao, A. Muller, A. K. Cheetham (Eds.) WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004. (Relevant pages)

A student should:

1. Various methods of nanoparticle synthesis
2. Stabilization of Nanoparticles in solution
3. Properties and Application of Nanoparticles
4. Know about carbon nanotube and its application

5. Chemical Toxicology [5L]

Toxic chemicals in the environment, Impact of toxic chemistry on enzymes. Biochemical effect of Arsenic, Cadmium, Lead and Mercury. Biological methylation.

A student should be able -

i) To know toxic chemical in the environment.

ii) To know the impact of toxic chemicals on enzyme.

iii) To know the biochemical effect of Arsenic, Cd, Pb, Hg.

iv) To explain biological methylation.

Reference:

i) Fundamental Chemistry by A. K. De (3rd Ed.)

ii) Environmental chemistry by A.K.De Publisher- Wiley Eastern Limited New Age International Limited Page No. 75-100.

DSEC-V: CH-606: Inorganic Chemistry Practical-II [Credit -2, 73 L]

Total 12 Experiments to be performed.

A. Volumetric Estimations (Any 3)

1. Analysis of Phosphate (PO_4^{3-}) from Fertilizer. (Ref-1)
2. Analysis of Iodine from Iodized salt.(Ref-2)

3. Strength of medicinal H_2O_2. (Ref-1)
4. Analysis of Calcium from milk powder. (Ref-1)
5. Analysis of Cu from Cu-Fungicide. (Ref-1)

B. Flame Photometry (Any 3) (Ref-1)

1. Estimation of Na by flame photometry by calibration curve method.
2. Estimation of Na by flame photometry by regression method.
3. Estimation of K by flame photometry by calibration curve method.
4. Estimation of K by flame photometry by regression method.

C. Column Chromatography (any 1) (Ref-1)

1. Purification of water using cation/anion exchange resin and analysis by qualitative analysis /conductometry.

D. Nanomaterial synthesis (Any 1) (Ref-3, 4)

1. Synthesis of Silver nanoparticles.
2. Synthesis of ZnO nanoparticles.

E. Verification of periodic trends using solubility of alkaline earth metal hydroxides $Ca(OH)_2$, $Mg(OH)_2$, $Cr(OH)_2$, $Ba(OH)_2$. (Ref-1)

F. Synthesis of amine complexes of Ni(II) and its ligand exchange reaction (bidentate ligands like acac, DMG, Glycine) by substitution method.

OR

Determination of the Metal to ligand ratio (M : L) in complexes. (Ref-5)

G. Solvent free microwave assisted one pot synthesis of pthalocynin copper (II) complex.

OR

Fenton reaction: Degradation of H_2O_2 using Fe catalyst. (Ref-6)

H. Table work: Band gap calculation for the nanomaterial TiO_2/ SnO_2/ ZnO from its electronic spectra (UV-Visible). (Ref-3, 4)

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, CRC press

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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Structure of Practical Examination [35 Marks; Time: 3 hours]

Q1. Expt. A/ B/ C/ D/ E/ F/ G/ H ……...30 M

Q2. Viva-Voce ……...05 M

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DSEC-VI: CH-607: Organic Chemistry-II [Credit -2, 36 L]

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Introduction to Spectroscopy	03
2	Ultra Violet and Visible Spectroscopy	06
3	Infra-Red Spectroscopy	08
4	Nuclear Magnetic Resonance Spectroscopy (PMR)	10
5	Combined problems based on U.V., I.R. and PMR spectroscopy	05
6	Stereochemistry of Disubstituted Cyclohexane and Decalin	04
	Total	**36**

1: Introduction to Spectroscopy [03 L]

Introduction, meaning of spectroscopy, Types of spectroscopy, nature of electromagnetic radiation and regions of electromagnetic spectrum, Terms used in spectroscopy; wavelength, amplitude, frequency, wavenumber, energy and their relations and conversions Ref 2: Page Nos. 43-55 Chapter

2: Ultra Violet and Visible Spectroscopy [06 L]

Introduction, Electromagnetic radiations, electronic transitions, λmax & εmax, chromophore, auxochrome, bathochromic and hypsochromic shifts, Application of visible, ultraviolet spectroscopy in organic molecules. Application of electronic spectroscopy and Woodward rules for calculating l max of conjugated dienes and α, β – unsaturated compounds. Ref 1: Page Nos.367-398

3: Infra-Red Spectroscopy [08 L]

Introduction, Infrared radiation and types of molecular vibrations, functional group 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 1: Page Nos 26-93

4: Nuclear Magnetic Resonance Spectroscopy (PMR) [10 L]

Introduction, Principles, Magnetic and nonmagnetic nuclei, nuclear resonance, chemical shift, shielding, & deshielding 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 1: Page Nos.108-175 and 225-366 Chapter 5: Combined Problems Based on U.V., I.R. and PMR Spectroscopy. [05 L] Ref 1: Page Nos. 501 to 567

5:Combined problems based on U.V., I.R. and PMR spectroscopy. [05 L]

Ref 1: Page Nos. 501 to 567

6: Stereochemistry of Disubstituted Cyclohexane and Decalin [04 L]

Recapitulation, Geometrical and optical isomerism of 1,3- dimethyl and 1,4-dimethyl cyclohexane with their stability and energy calculations. Conformations of decalin and their stability.

Ref.19: Pages 94, 213 - 216, 250. Ref.20: Pages 243 – 250, 289-292.

References:

1. Pavia D.L.; Lampman G.M. Kriz G. S.; Vyvyan J.R. Spectroscopy, First Indian Reprint 2008 : Brooks/Cole CENGAGE Learning.
2. Silverstein and Basallar: Spectroscopic Identification of Organic Compounds.
3. M. Parikh :Absorption Spectroscopy Organic Compounds (John Wiley)
4. P. S. Kalsi : Spectroscopy of organic compounds (New Age)
5. J. R. Dyer: Application of absorption spectroscopy of organic compounds.
6. V. M. Parikh:Application spectroscopy of Organic molecules. (Mehata)
7. D.W. Williams and Flemming: Spectroscopic methods of Organic compound.
8. Jackman and Stermineil: Application of NMR spectroscopy
9. J. D. Roberts:Nuclear magnetic resonance (J. Wiley)
10. Jaffe and Orchin: Theory and application of U. V.
11. K. Benjamin: Mass spectroscopy
12. Budsikiewicy et al.: Mass spectroscopy.
13. Beynon J H et al: The mass spectra of organic molecules.
14. W. Kemp: Organic spectroscopy ELBS
15. Atherben; Electron spin resonance
16. Das and Jame: Mass Spectroscopy.
17. Eliel: Stereochemistry of Organic Compounds, Tata Mc Graw Hill, 1989
18. D. Nasipuri: Stereochemistry of Organic Compounds- Principles and Applications, New Age International Publishers, 3rd edition.

Learning Outcomes

Chapter 1 to 5: Organic Spectroscopic Methods in Structure Determination. (Chapter 1-5)
Students will learn the interaction of radiations with matter. They will understand different regions of electromagnetic radiations. They will know different wave parameters.

1. Students will learn the principle of mass spectroscopy, its instrumentation and nature of mass spectrum.
2. Students will understand the principle of UV spectroscopy and the nature of UV spectrum. They will learn types of electronic excitations.
3. Students will be able to calculate maximum wavelength for any conjugated system. And from the value of λ-max they will be able to find out the extent of conjugation in the compound.
4. Students will understand the principle of IR spectroscopy, types of vibrations and the nature of IR spectrum.
5. From the IR spectrum, they will be able to find out IR frequencies of different functional groups. And thus, they will be able to find functional groups present in the compound.
6. Students will understand the principle of NMR spectroscopy and will understand various terms used in NMR spectroscopy. They will learn measurement of chemical shift and coupling constants.
7. Students will be able to interpret the NMR data and they will be able to use it for determination of structure of organic compounds.
8. Students will be able to determine the structure of simple organic compounds on the basis of spectral data such as λ max values, IR frequencies, chemical shift (δ values).

Chapter 6: Students should be able to learn

1. The use of models to draw different types of disubstituted cyclohexanes in chair form
2. The geometrical isomerism in disubstituted cyclohexanes
3. The stability, energy calculations and optical activity of these conformers
4. The use models and to draw different types of conformational isomers of decalin in chair form
5. To know the stability of geometrical isomers of decalin

DSEC-VI: CH-608: Organic Chemistry-III [Credit -2, 36 L]

Synthetic Organic Chemistry

Chapter No	Chapter	No of Lectures
1	Retrosynthetic Analysis and Applications	06
2	Organic Reaction Mechanism and Synthetic Applications	12
3	Reagents in Organic Synthesis	10
4	Natural Products	08

1. Retrosynthetic Analysis and Applications [06 L]

Introduction, Different terms used – Disconnection, Synthons, Synthetic equivalence, FGI, TM. One group disconnection, Retrosynthesis and Synthesis of target molecules: Acetophenone, Crotonaldehyde, Cyclohexene, Benzylbenzoate, and Benzyl diethyl malonate.

Ref 1: *Page Nos. 1-34* ***Ref. 2:*** *Page Nos. 694-722*

2. Organic Reaction Mechanism and Synthetic Applications [12 L]

1. Chemistry of reactive intermediates (carbocations, carbanions, free radicals, carbenes, nitrenes, benzynes etc…);
2. Wolff rearrangement (Step up),
3. Hofmann rearrangement (Step down),
4. Simmons-Smith reaction,
5. Michael reaction,
6. Wittig reaction and McMurry reaction,
7. Diels-Alder reaction,
8. Functional group interconversions and structural problems using chemical reactions.

Ref 2 *Page Nos. 1021-1022,* *1009-1018, 500, 237-238, 982-983, 877-893*

3. Reagents in Organic Synthesis [10 L]

Reagents- Preparation and Applications of following reagents.

Reducing Reagents: ***Ref 2*** *Pages Nos. 226, 828, 131-132, 26, 39, 537*

Lithium aluminium hydride $LiAlH_4$, $NaBH_4$, DIBAL-H, $Li(tBuO)_3AlH$ & Raney Nickel.

Oxidizing Reagents: ***Ref. 2*** *Page Nos. 545, 1123-1126, 919, 764*

1. DMSO either with DCC or Ac_2O, Dess Martin reagent, Osmium tetroxide, Selenium dioxide-(SeO_2), DDQ.

4. Natural Products [08 L]

Ref 2: *Page Nos. 1413-1447*

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.

Reference:

1.Designing Organic Synthesis by Stuart Warren 1983.

2.Organic Chemistry by Clayden, Greeves, Warren and Wothers.Second edition.

3.Organic Chemistry by I. L. Finar Vol. II Edn.V.

4.Organic Chemistry by Morrison and Boyd. VI Edn.

A Guidebook to Reaction Mechanism by Peter Sykes VI Edn.

DSEC-VI: CH-609: Organic Chemistry Practical-II [Credit -2, 73 L]

Total 12 Experiments to be performed

A) Interpretation of IR and NMR spectra (2 Experiments of each type)

1. Determination of functional group of organic compound from given IR spectra.
2. 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)

B) Organic Estimations (Any Three)

1. Estimation of glucose
2. Estimation of glycine
3. Saponification value of oil
4. Estimation of Alkali content in Antacid using HCl.

C) Organic Extractions (Any Three)

1. Caffeine from tea leaves
2. Eugenol from cloves
3. Lycopene from tomato peels
4. Cinnamic acid from cinnamon
5. Trimyristin from nutmeg

D) Column chromatography

1. Separation of mixture of aldehyde and carboxylic acid by column chromatography
2. Separation of mixture of O-nitrophenol and P-nitrophenol by column chromatography

Learning Outcomes:

A) Interpretations of IR and PMR Spectra The students will be able to

1. Explain “fingerprint region” of an infrared spectrum can used in the identification of an unknown compound.
2. Identify the functional group or groups present in a compound.
3. Identify the broad regions of the infrared spectrum in which occur absorptions caused by N−H, C−H, and O−H, C≡C and C≡N, C=O, C=N, and C=C.
4. Understand use NMR spectra to determine the structures of compounds.
5. Interpret integration of NMR spectra
6. Calculate coupling constants from 1 H NMR spectra.
7. Interpret elemental analysis technique

B) Organic Estimations The students will be able to

1. Practical knowledge of handling chemicals.
2. Achieve the practical skills required to estimations of glucose and glycine.
3. Achieve the practical skills required to Saponification value of oil.
4. Determine the molecular weight of given tribasic acids.

C) Organic Extractions The students will be able to

1. Apply the principles of extraction
2. Understand the equipment for extraction.
3. Gain practical hands-on experience of modern Extraction.
4. Develop basic design of extractor
5. Describe the extraction separation process.

D) Column chromatography The students will be able to

1. Defines the basic parameters in chromatography
2. Explain the processes of a chromatography analysis
3. Describes the types and materials of column.
4. Explains the types of mobile phase and elution.
5. Realize the selection of appropriate mobile phase, column and detector

SEC-III: CH-610: Skill Enhancing Course-III [Credit -2, 36 L]

Choose one out of the two options, A and B.

CH-610 (A) : Chemistry of Soil and Agrochemicals

Chapter No	Name of the Topic	Number of lectures
1	Soil Chemistry	6
2	Problematic Soil and Soil testing	6
3	Laboratory Methods of Soil Analysis	12
4	Fertilizers and Manures	6
5	Protection of Plants	6
	Total Lectures	**36**

1. Soil Chemistry (6 L)

1.1 Role of agricultural chemistry

1.2 Introduction to soil chemistry, definitions of soil, Soil components- Mineral component, organic matter or humus, soil atmosphere, soil water, soil microorganism.

1.3 Physical properties of soil- Soil texture, soil structure, soil colour, soil temperature, soil density, porosity of soil.

1.4 Surface soil and sub-soil, Functions of soil.

1.5 Chemical properties of soil - Soil reactions, importance of soil reaction, factors controlling soil reactions,

1.6 Buffer action, buffering capacity, importance of buffer reaction in agriculture, ion exchange and importance of ion exchange.

Ref 1- Pages 8-12, 92-94, 98-113, 116-146

Ref 3 - Pages 28-50

Ref 12 - Pages 211-224, 228-234

Ref 17 - Pages 49-56, 295-308, 357-370

2. Problematic Soil and Soil testing (06 L)

2.1 Introduction to problematic soils.

2.2 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.

2.3 Alkali Soil- formation of alkali soil, reclamation of alkali soil.

2.4 Classification of alkali soil- saline soil, alkali soil, saline alkali soil, non-saline alkali soil.

2.5 Soil testing - Introduction, different methods of soil fertility evaluation.

2.6 Objectives of soil testing.

Ref 1- Pages 345-370

Ref 3 - 301-312

Ref 4 – Pages 135-147, 150-159

Ref 12 - Pages 237-246, 337-353

3. Laboratory Methods of Soil Analysis (12 L)

3.1 Collection of soil Samples from field.

3.2 Soil sample preparation for analysis of various parameters.

3.3 Digestion and Extraction Procedures for soil.

3.4 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. It is considered for internal marks of this course**).

1. Determination of pH of soil
2. Determination of EC and TDS of soil
3. Determination of soil organic matter of soil.
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, Salinity of soil. Interpretation of soil data and recommendations for soil use.

Ref 23 pages 11-160

Ref 25 pages 17-104

4. Fertilizers and Manures (06 L)

Fertilizers

4.1 Introduction, Classification of nitrogenous fertilizers, reaction of ammonium sulphate, urea as a fertilizer in soil.

4.2 Nano fertilizers- Nano-Fertilizers for Sustainable Crop Production, Nano urea- preparation, forms and application of nano urea.

4.3 Phosphatic fertilizers- Classification of phosphatic fertilizers, reactions of superphosphate as a fertilizer in soil.

4.4 Potassic fertilizers - Classification of potassic fertilizers, reactions of potash fertilizer in soil.

4.5 Complex fertilizers- Characteristics, advantages and disadvantages,

4.6 Mixed fertilizers - Characteristics, advantages and disadvantages.

4.7 Time and mode of applications of fertilizers in the solid and liquid form to plants.

4.8 Factors affecting efficiency of fertilizers.

Manures

4.9 Introduction, Definition and classification of manures.

4.10 Effect of bulky organic manures on soil.

4.11 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.

4.12 Biofertilizers - Definition, classification, role & advantages.

4.13 Vermicompost - Preparation, effect of vermicompost on soil fertility.

Ref 2- Pages 205-213,

Ref 3- Pages 90-112, 137-149

Ref 5 Pages Relevant pages

Ref 12 – Pages 263- 275, 280-290,

Ref 18 – URL: Attached in reference.

Ref 19 - URL: Attached in reference.

Ref 20 URL: Attached in reference.

5. Protection of Plants (06 L)

5.1 Classification of pesticides.

5.2 Insecticide- Definition, Classification on the basis of mode of action and chemical properties.

5.2.1 Inorganic insecticides - plants or animal origin insecticides- nicotine, pyrethrum, rotenone.

5.2.2 Synthetic organic insecticides – a) Organochlorine insecticides - DDT, BHC, Aldrin and dieldrin. b) Organophosphorus insecticides – Parathion, Malathion, c) Carbamate insecticides – Carbaryl, Baygon.

5.3 Fungicide – Definition and Classification of fungicides.

5.3.1 Inorganic fungicide- Copper fungicides a) Bordeaux mixture, b) Copper oxychloride.

5.3.2 Organic fungicides- Dithiocarbamate, Quinone fungicides, Heterocyclic fungicides.

5.3.3 Synthetic fungicides.

5.4 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.

5.5 Nano pesticides: Its Scope and Utility in Pest Management

Ref 6 - Relevant Pages

Ref 13 – Pages 80-177,

Ref 14 – Pages 73-110,

Ref 15 – Chapter 3 Pages 1-45

Ref 16 Pages 2-16,

Ref 19 URL: Attached in reference.

Ref 21 URL: Attached in reference.

Learning Objectives:

1) Know the different components and properties of soil.
2) Know classification of soil on the basis of pH.
3) Identify the problematic soil and recommend method for their reclamation.
4) Know the different plant nutrients required for plants and their functions.
5) Know the role of various fertilizers and manures required for plant growth.
6) Know the various methods and their techniques in analysis of soil.
7) Know importance of manures as compared to chemical fertilizers.

8) Know various techniques to protect the plants.
9) Have the knowledge of various pesticides, insecticides, fungicides and herbicides.

Course Outcomes:

After studying this course, student is expected to

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.

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 Soft copy 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 revised ed., 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. Book Soft 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 copy URL: 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. Nano fertilizers, Nano Urea- URL: https://www.iffco.in/
19. Nano fertilizers & Nano Pesticides, URL: https://www.sciencedirect.com/science/article/pii/S0570178320300440 , https://www.sciencedirect.com/science/article/pii/B9780128200926000124
20. Biofertilizers, URL: https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/biofertilizers , https://agritech.tnau.ac.in/ta/org_farm/orgfarm_biofertilizers.html, https://en.wikipedia.org/wiki/Biofertilizer
21. Nano Pesticides, URL: https://link.springer.com/article/10.1007/s10311-016-0600-4

22. A Practical Course in Agricultural Chemistry, D. W. Gilchrist Shirlaw and J. E. Nichols, First ed. Pergamon Press Ltd. Headington Hill Hall Oxford4 & 5 Fitzroy Square, London. 1967. Book Soft copy URL: https://1lib.in/book/2275633/04aec0
23. Laboratory Guide for Conducting Soil Tests and Plant Analysis, J. Benton Jones Jr. CRC Press, 2001. Book Soft copy URL: https://1lib.in/book/665386/63e6f0
24. 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=sharing
25. Methods in Agricultural Chemical Analysis: A Practical Handbook: N.T. Faithfull, CABI Publishing, 2002, Book Soft copy URL: https://1lib.in/book/917802/0b4a71

CH-610 (B) Introduction to Forensic Chemistry

Chapter No	Name of the Topic	Number of lectures
1	History of Development of Forensic Science in India	10
2	Introduction to Narcotics Drugs and Psychotropic Substances	10
3	Analysis of Narcotics Drugs and Psychotropic Substances	16
	Total Lectures	**36**

1. History of Development of Forensic Science in India [10 L]

Functions of forensic science. Historical aspects of forensic science. Definitions and concepts in forensic science. Scope of forensic science. Need of forensic science. Basic principles of forensic science. Frye case and Daubert standard. Work nature of forensic science. Qualifications of forensic scientists. Duties & Code of conduct for forensic scientists.

Learning Objectives: After studying this paper the students will know –

a. The significance of forensic science to human society.

b. The fundamental principles and functions of forensic science.

c. The work nature in a forensic science laboratory.

d. Encourage academic students towards the noble career

Suggested Readings

1. B.B. Nanda and R.K. Tiwari, *Forensic Science in India: A Vision for the Twenty First Century*, Select Publishers, New Delhi (2001).

2. M.K. Bhasin and S. Nath, *Role of Forensic Science in the New Millennium*, University of Delhi, Delhi (2002).

3. S.H. James and J.J. Nordby, *Forensic Science: An Introduction to Scientific and Investigative Techniques*, 2nd Edition, CRC Press, Boca Raton (2005). Page No : 1-13, 243-260, 667-678

4. W.G. Eckert and R.K. Wright in *Introduction to Forensic Sciences*, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997). Page No: 11-78

5. R. Saferstein, *Criminalistics*, 8th Edition, Prentice Hall, New Jersey (2004).Page No 5-29

6. W.J. Tilstone, M.L. Hastrup and C. Hald, *Fisher's Techniques of Crime Scene Investigation*, CRC Press, Boca Raton (2013) Page No : 26-149

7. Directorate of Forensic Science services (DFSS) http://dfs.nic.in/index.html

2. Introduction to Narcotics Drugs and Psychotropic Substances [10 L]

Definition of narcotics drugs and psychotropic substances. Broad classification – Narcotics, stimulants, depressants and hallucinogens. General characteristics and common example of each classification. Natural, synthetic and semi-synthetic narcotics drugs and psychotropic substances. Designer drugs. Tolerance, addiction and withdrawal symptoms of narcotics, drugs and psychotropic substances. Introduction to NDPS Act-1985 and awareness about Punishment for Offences.

3. Analysis of Narcotics Drugs and Psychotropic Substances [16 L]

Crime scene search for narcotic drugs and psychotropic substances – searching a suspect, searching a dwelling, searching a vehicle. Clandestine drug laboratories. Collection and preservation of drug evidence. Testing of narcotics drugs and psychotropic substances. Isolation techniques for purifying narcotics drugs and psychotropic substances – thin layer chromatography, gas-liquid chromatography and high performance liquid chromatography. Presumptive and screening tests for narcotics drugs and psychotropic substances. Microcrystalline testing of Drug Abuse and Illicit Trafficking. Analysis of narcotics drugs and psychotropic substances in urine, and antemortem blood & in postmortem blood. Dope tests.

Learning Objectives: After studying this paper the students will know –

a. The forensic identification of illicit liquors.

b. The classification and characteristics of the narcotics, drugs and psychotropic substances.

c. The menace of designer drugs.

d. The methods of identifying of narcotics, drugs and psychotropic substance

Suggested Readings

1. R. Saferstein, *Criminalistics*, 8th Edition, Prentice Hall, New Jersey (2004). Page No 10-26

2. S.B. Karch, *The Pathology of Drug Abuse*, CRC Press, Boca Raton (1996). Page No: 429-638

3. A. Poklis, Forensic toxicology in, *Introduction to Forensic Sciences*, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton (1997).Page No : 116-141

4. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, *Techniques of Crime Scene Investigation*, CRC Press, Boca Raton (2013). Page No 323-337

5. THE NARCOTIC DRUGS AND PSYCHOTROPIC SUBSTANCES, ACT, 1985 https://legislative.gov.in/sites/default/files/A1985-61.pdf

6. THE NARCOTIC DRUGS SUBSTANCES AND PSYCHOTROPIC RULES, 1985 https://dor.gov.in/sites/default/files/Narcotic-Drugs-and-Psychotropic-Substances-Rules-1985_0.pdf

6. National Policy on NDPS Govt. of India https://dor.gov.in/narcoticdrugspsychotropic/national-policy-ndps

7.National Policy on NDPS & Punishment for Offences https://dor.gov.in/narcoticdrugspsychotropic/punishment-offences

8. J.W. Robinson, *Undergraduate Instrumental Analysis*, 5th Edition, Marcel Dekker, Inc., New York (1995). Page No : 721-797

9. Analytical Techniques in Forensic Science Rosalind Wolstenholme, Sue Jickells, Shari Forbes, edition first edition 2021 John Wiley & Sons Ltd Page No; 51-68

10. FORENSIC ANALYTICAL TECHNIQUES Barbara Stuart University of Technology, Sydney, Australia, first edition 2013 John Wiley & Sons, Ltd. 143-166

SEC-IV: CH-610: Skill Enhancing Course-IV [Credit -2, 36 L]

Choose one out of the two options, A and B.

CH-611(A): Analytical Chemistry-II

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Solvent extraction	08
2	Instrumental Methods of Chromatographic Analysis	04
3	High Performance Liquid Chromatography	06
4	Gas Chromatography	06
5	Atomic Absorption Spectroscopy	08
6	Flame Emission Spectroscopy	04
	Total	**36**

1. Solvent extraction (8 L)

Introduction to solvent extraction, organic phase, Partition the theory of extraction (distribution coefficient, Distribution ratio, solute remaining unextracted, Separation coefficient), Factors favoring solvent extraction, Quantitative treatment to solvent extraction equilibrium, Ion association complexes, synergic extraction, some extraction reagent specifically used for inorganic ions (Acetylacetone, 8-Hydroxyquinoline, Diphenylthiocarbazone, Sodium diethyldithiocarbamate, Ammonium pyrrolidine dithiocarbamate), some practical aspects, Applications: determination of copper as the diethyldithiocarbamate complex, Determination of Fe(III) with 8-hydroxyquinoline, determination of nickel by synergistic extraction. Solid phase extraction (Ref-3) Numericals; **Key Reference-2**: 242- 253, [Supplementary Ref-3: 579-593]

2. Instrumental Methods of Chromatographic Analysis (4 L)

Principles of Chromatographic Separations, classification, Theory of Column Efficiency in Chromatography, (theoretical plate, rate theory of chromatography - the Van Deemter equation, efficiency and particle size in HPLC, retention factor efficiency and resolution,

Key Reference -4: 603-617, Supplementary reference-3: 547-556.

3. High Performance Liquid Chromatography (6 L)

Introduction, Types of liquid chromatography (liquid-solid, liquid-liquid, bonded phases), Choice of mode of separation, Equipment for HPLC: mobile phase, sample injection and column design (mobile phase, optimization of mobile phase, gradient elution, solvent delivery and sample injection, sample injection system, the column (effect of column length and column diameter), Choosing the Detector, Ultraviolet detector, Luminescence detector, RI detector, electrochemical detector, Column efficiency, HPLC chromatogram and its characteristics (retention time, peak height, peak area), method of quantitative analysis by HPLC, Example: determination of aspirin, phenacetin and caffeine in a mixture, numerical, **Key Reference -2:** 289-315, [Supplementary reference - Ref-3: 649 – 724, Ref-6: 1-325 -relevant part

4. Gas Chromatography (6 L)

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

Key Reference-2: 317- 337, [Supplementary reference - 7: 1-209 (relevant part)]

5. Atomic Absorption Spectroscopy (8 L)

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.

Key Ref-2: 612 – 643

6. Flame Emission Spectroscopy (4 L)

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,

Key Reference-2: 645-649, 655-656

References:

Ref-1: Vogel's textbook of Inorganic Quantitative Analysis, Jeffery, Basset, Mendham Deney, 5th Ed, Longman Scientific Technical, USA (copublished with John Wiley Sons)

Ref-2: Vogel's textbook of Inorganic Quantitative Analysis, Mendham, Deney Barnes, 6th Ed, Pearson education

Ref-3: Analytical Chemistry by G. D. Christian, et al , Wiley, 6th Ed.

Ref-4: Principles of Instrumental Analysis: Holler, Skoog, Crouch 6th Ed. Thomson Publication

Ref-5: Modern Analytical Chemistry, David Harvey, Mc-Graw Hill Higher education

Ref-6: High performance Liquid Chromatography, (Analytical Chemistry through open learning series) Second Ed, Sandie Lindsay, Wiley

Ref-7: Gas Chromatography, (Analytical Chemistry through open learning series) 2nd Ed, Ian A. Fowlis, Wiley

Course outcome: After completion of the course student should able to

1. Define basic terms in solvent extraction, basics of chromatography, HPLC, GC, and AAS and AES. Some important terms are: solvent extraction, aqueous and organic phase, distribution ratio and coefficient, solute remain unextracted, percent extraction, ion association complex, 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, atomic absorption and emission spectroscopy, electronic excitation in atoms, nebulization, atomization, reduction of metal ions in flame, absorbance by atoms in flame, flame atomizers, furnace atomizers, interference in AES and FES, HCL, hydride generator, etc.

2. Identify important parameters in analytical processes or estimations. Example: minimum analyte concentration in particular method, reagent concentration for particular analysis, reagent for particular analysis, reaction condition to convert analyte into measurable form, wavelength selection in HPLC with spectrophotometric and fluorometric detector, solvent or carrier gas in HPLC and GC, choice method for the sample preparation in atomic spectroscopic methods, choice of filter and HCL in atomic spectroscopic methods, etc.

3. Explain different principles involved in the analyses using solvent extraction, basics of instrumental chromatography, HPLC, GC, and atomic spectroscopic techniques.

4. Perform quantitative calculations depending upon equations students has studied in the theory. Furthermore, student should able to solve problems on the basis of theory.

5. Discuss / Describe procedure for different types analyses included in the syllabus.

6. Select particular method of analysis if analyte sample is given to him.

7. Differentiate / distinguish / compare among the different analytical terms, process and analytical methods.

8. Demonstrate / explain theoretical principles with help of practical.

9. Design analytical procedure for given sample.

10. Apply whatever theoretical principles he has studied in theory during practical in laboratory.

CH-611 (B): Chemistry of Cosmetics and Perfumes

Chapter No.	Title of Topic/Chapter	No. of lecture
1	Chemical composition, preparation and uses of some cosmetics	12
2	Chemistry of Perfumes and fragrances	12
3	Rules and regulations for cosmetic industry	12
	Total	**36**

1. Chemical composition, preparation and uses of some cosmetics [12 L]

A general study including chemical composition, preparation and uses of the following:

Hair dye, hair spray, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), Eye make-up (Mascara, Eyeshadow, Eyeliner, Eyebrow pencil), Antiperspirants,***(Ref. 1** – all relevant pages, Ref. 2 Pp. 149 - 177, 187 to 199, 233 to 255, 263, 291 to 310, 323 to 346, 406 to 422, 437 to 452, 457 to 490, 519 to 522**)***

2. Chemistry of Perfumes and fragrances [12 L]

History of perfume, classification sources of fragrance, Development and role of natural products in cosmetics, Extraction of Essential oils and their importance and uses in cosmetic industries with reference to Chemistry of - Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-

phenyl ethyl alcohol, Jasmone, Civetone, Muscone. **(*Ref. 3 Pages 3 to 67 and relevant pages from 68 to 360*)**

3. Rules and regulations for cosmetic industry [12 L]

Understanding of regulations of Central Drugs Standard Control Organization, India Cosmetic Regulation, Steps for process of cosmetic registration in India **(*Ref. 4, 5, 6*)**

4. Projects: (students can choose any one of the following projects and submit a project report at the end of semester for evaluation**)**

1. Preparation of talcum powder. **(*Ref.2 Pages 263*)**
2. Preparation of shampoo. **(*Ref.2 Pages 323 to 346*)**
3. Preparation of enamels. **(*Ref.2 Pages 495 to 522)***
4. Preparation of hair remover. **(*Ref.2 Pages 425 to 434*)**
5. Preparation of face cream. **(*Ref.2 Pages 149 to 177*)**
6. Preparation of nail polish and nail polish remover. **(*Ref.2 Pages 505 to 522*)**
7. Preparation of Emulsified and solid fragrances. **(*Ref.2 Pages 575 to 583*)**
8. Isolation of Simple Floral fragrances and Alcoholic fragrances solution. **(*Ref.2 Pp 569 to 573*)**

Reference Books:

1. Cosmetic Formulation: Principles and Practice - Heather A.E. Benson, Michael S. Roberts, Vania Rodrigues Leite-Silva, Kenneth Walters
2. COSMETICS Formulation, Manufacturing & Quality Control, Fourth Edition - P. P. Sharma, M pharm
3. Perfumes, Cosmetics and soaps, ninth edition, – W. A. Poucher.
4. **https://cdsco.gov.in/opencms/opencms/en/Cosmetics/cosmetics**
5. **https://cosmetic.chemlinked.com/cosmepedia/india-cosmetic-regulation**
6. **https://morulaa.com/cdsco/process-cosmetics-registration-india**

Additional References :

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).
3. Indian medical plants: by Kirtikar & Basu
4. Naturals and Cosmetics – by Dr. Satish Sakharwade
5. Manufacture of Perfumes, Cosmetics & Detergents – Giriraj Prasad
6. Perfumes: History & Chemistry Vol-I- Dr. D. D. Wasule
7. Cosmetics: Science & Technology – Sagarin.
8. Essential oils Vol. I by Gunther.
9. Perfume flowers & essential oil industries by S.B. Srivastva.