Savitribai Phule Pune University, Pune
T.Y.B.Sc. Chemistry Syllabus

To be implemented from June 2015
(Academic Year 2015-16)
Preamble of the Course

1. T.Y.B.Sc. Chemistry is consisting of six theory and three practical courses.
2. Each theory course is of 48 lectures; 4 lectures per course per week should be conducted in every semester.

3. Out of five optional courses recommended for CH-336 and CH-346, only one option should be taught and the same course should be implemented for the next semester.

4. Each practical course is of 4 lectures per week per batch. Practical batch for each course should comprise of 12 students only.

5. Each theory paper will carry 50 Marks out of which 10 Marks will be allotted for Internal assessment and University Examination will be conducted for 40 Marks at the end of each semester.

6. The practical examination of six hours for each practical course will be conducted at the end of Semester-IV. Each practical course will carry 100 Marks out of which 20 Marks will be allotted for Internal assessment and University Examination will be conducted for 80 Marks.

7. **Marks for internal assessment of Practical courses will be allotted as follows.**
   a. Completed and Certified journal and regularity of the student 10 Marks
   b. Oral Examination and Internal Test 10 Marks

8. Internal assessment for theory courses will be done on the basis of the performance of the student in tests. Minimum two tests should be arranged for each course in a Semester.

9. Visit to a chemical industry may be organized during the academic year.

Savitribai Phule Pune University
Board of Studies in Chemistry
T.Y.B.Sc. Chemistry Syllabus

Structure to be implemented from June 2015 (i.e. from Academic Year 2015-16)

Semester	Course Code and Title	Number of Lectures	Marks
Semester III	CH-331: Physical Chemistry	48	50
	CH-332: Inorganic Chemistry	48	50
	CH-333: Organic Chemistry	48	50
	CH-334: Analytical Chemistry	48	50
	CH-335: Industrial Chemistry	48	50
	OPTIONAL COURSE CH-336-A Nuclear Chemistry**OR** CH-336-B Polymer Chemistry**OR** CH-336-C Introduction to Biochemistry and Molecular Biology **OR** CH-336-D Environmental and Green Chemistry**OR** CH-336-E Agriculture Chemistry	48	50
Semester IV	CH-341: Physical Chemistry	48	50
	CH-342: Inorganic Chemistry	48	50
	CH-343: Organic Chemistry	48	50
	CH-344: Analytical Chemistry	48	50
	CH-345: Industrial Chemistry	48	50
	OPTIONAL COURSE CH-346-A Nuclear Chemistry**OR** CH-346-B Polymer Chemistry**OR** CH-346-C Introduction to Biochemistry and Molecular Biology **OR** CH-346-D Environmental and Green Chemistry**OR** CH-346-E Dairy Chemistry	48	50
	PRACTICAL COURSES		
	CH-347: Physical Chemistry Practicals		100
	CH-348: Inorganic Chemistry Practicals		100
	CH-349: Organic Chemistry Practicals		100

NOTE

1. Each theory paper will carry 50 Marks out of which 10 Marks will be allotted forinternal assessment and University Examination will be conducted for 40 Marks atthe end of each semester.

2. The practical examination will be conducted at the end of Semester-IV. Each practicalcourse will carry 100 Marks out of which 20 Marks will be allotted for internalassessment and University Examination will be conducted for 80 Marks.

3. Marks for internal assessment of Practical courses will be allotted as follows.

a. Completed and certified journal 10 Marks

b. Overall performance and regularity of the student during whole academic year 10 Marks

4. Internal assessment for theory courses will be done on the basis of the performance ofthe student in tests. Minimum two tests should be arranged for each course in aSemester.

Date: 29/04/2015

Dr. B. R. Khot
Chairman,
BOS in Chemistry

Savitribai Phule Pune University

Board of Studies in Chemistry

T.Y.B.Sc. Chemistry Syllabus

To be implemented from June 2015 (i.e. from Academic Year 2015-16)

Equivalenceof the Courses

Semester	Course Code and Title (Old)	Course Code and Title (New)
Semester III	CH-331: Physical Chemistry	CH-331: Physical Chemistry
	CH-332: Inorganic Chemistry	CH-332: Inorganic Chemistry
	CH-333: Organic Chemistry	CH-333: Organic Chemistry
	CH-334: Analytical Chemistry	CH-334: Analytical Chemistry
	CH-335: Industrial Chemistry	CH-335: Industrial Chemistry
	OPTIONAL COURSE CH-336-A Nuclear Chemistry CH-336-B Polymer Chemistry CH-336-C Introduction to Biochemistry and Molecular Biology CH-336-D Environmental Chemistry CH-336-E Agriculture Chemistry	**OPTIONAL COURSE** CH-336-A Nuclear Chemistry CH-336-B Polymer Chemistry CH-336-C Introduction to Biochemistry and Molecular Biology CH-336-D Environmental and Green Chemistry CH-336-E Agriculture Chemistry
Semester IV	CH-341: Physical Chemistry	CH-341: Physical Chemistry
	CH-342: Inorganic Chemistry	CH-342: Inorganic Chemistry
	CH-343: Organic Chemistry	CH-343: Organic Chemistry
	CH-344: Analytical Chemistry	CH-344: Analytical Chemistry
	CH-345: Industrial Chemistry	CH-345: Industrial Chemistry
	OPTIONAL COURSE CH-346-A Nuclear Chemistry CH-346-B Polymer Chemistry CH-346-C Introduction to Biochemistry and Molecular Biology CH-346-D Environmental Chemistry CH-346-E Dairy Chemistry	**OPTIONAL COURSE** CH-346-A Nuclear Chemistry CH-346-B Polymer Chemistry CH-346-C Introduction to Biochemistry and Molecular Biology CH-346-D Environmental and Green Chemistry CH-346-E Dairy Chemistry
	PRACTICAL COURSES	**PRACTICAL COURSES**
	CH-347: Physical Chemistry Practicals	CH-347: Physical Chemistry Practicals
	CH-348: Inorganic Chemistry Practicals	CH-348: Inorganic Chemistry Practicals
	CH-349: Organic Chemistry Practicals	CH-349: Organic Chemistry Practicals

Date: 29/04/2015

Dr. B. R. Khot
Chairman,BOS in Chemistry

Semester-III
Course: Physical Chemistry (CH-331)

Topic	No. of Lectures
1. Chemical Kinetics	10
2. Electrolytic Conductance	14
3. Investigation of Molecular Structure	16
4. Phase Rule	08
Total Lectures	**48**

1. Chemical Kinetics : [10 L]

Recapitulation of Chemical Kinetics, Third order reaction, Derivation of integrated rate law for third order reaction with equal initial concentration, characteristics of third order reaction, examples of third order reaction, Methods to determine order of reaction using Integrated rate equation method, Graphical method, Half-life method, Differential method. Effect of temperature on reaction rate, Arrhenius equation, related numerical.

[Ref. 1 : Pages 567-574, Ref. 2: Pages 600-612]

2. Electrolytic Conductance: [14 L]

Recapitulation of Electrolytic conductance,Specific and equivalent conductance,Variation of equivalent conductance with concentration,

Kohlrausch's law and its applications to determine

a. Equivalent conductance at infinite dilution of a weak electrolyte,
b. The ionic product of water,
c. Solubility of sparingly soluble salts,

Migration of ions and ionic mobilities, absolute velocity of ions, Transport number determination by Hittorf's method and moving boundary method, Relation between ionic mobility, ionic conductance and transport number, Ionic theory of conductance, Debye-Huckel –Onsager equation and its validity, Activity in solution, fugacity and activity coefficient of strong electrolyte.

[Ref. 1 : Pages 398-437, Ref. 2 : Pages 686-703]

3. Investigations of Molecular Structure: [16 L]

Molar refraction, Electrical polarization of molecules, Permanent dipole moment, Determination of dipole moment, Molecular spectra - Rotational, vibrational and Raman spectra Reference

[Ref. 1 : pages 691-710 Ref. 2 : Pages 398-424]

4. Phase Rule: [08 L]

Definitions, Gibb's phase rule, one component system (moderate pressure only) for sulphur and water system, two component system for silver-lead and zinc-cadmium.

[Ref. 1 : Pages 344-350, 350-354; Ref. 2 Pages 558-575]

AIMS AND OBJECTIVES:

1. **Chemical Kinetics :** After studying this topic students are expected to know-
   i. Expression for rate constant k for third order reaction
   ii. Examples of third order reaction
   iii. Characteristics of third order rate constant k
   iv. Derivation for half-life period of third order reaction and to show that half-life is inversely proportional to square of initial concentration of reactants.
   v. Experimental determination of order of reaction by Integrated rate equation method, Graphical method, Half-life method and Differential method.
   vi. Explain the term energy of activation with the help of energy diagram
   vii. Explain the term temperature coefficient.
   viii. Effect of temperature on rate constant k
   ix. Derivation of Arrhenius equation
   x. Graphical evaluation of energy of activation
   xi. Solve the numerical problems based on this topic.

2. **Electrolytic Conductance :** After studying this topic students are expected to know-
   i. Ohm's law and electrical units such as coulomb, Ampere, Ohm and Volt.
   ii. Meaning of specific resistance, specific conductance, cell constant and their units.
   iii. Cell constant, its theoretical and experimental determination.
   iv. Preparation of conductivity water.
   v. Experimental determination of conductance.
   vi. Variation of specific and equivalent conductance of strong and weak electrolyte with dilution
   vii. Meaning of infinitely dilute solution.
   viii. Kohlrausch's law of independent migration of ions and its applications such equivalent conductance of weak electrolyte at zero conc., degree of dissociation (α),ionic product of water.
   ix. Transport number of an ion
   x. Hittorf's rule
   xi. Experimental determination of transport number by Hittorf's and moving boundary method.
   xii. Drawbacks of Arrhenius theory, Debye-Huckel-Onsager Interionic Attraction theory
   xiii. Asymmetry /Relaxation effect
   xiv. Electrophoretic effect
   xv. Validity of Onsager equation
   xvi. Fugacity and activity concept
   xvii. Activity and activity coefficient of strong electrolyte.
   xviii. Solve the numerical problems based on this topic.
   xix.
3. **Investigation of molecular structure :** After studying this topic students are expected to know-
   i. Understand the term additive and constitutive properties
   ii. Understand the term specific volume, molar volume and molar refraction.
   iii. Understand the meaning of electrical polarization of molecule.

iv. Understand the meaning of induced and orientation polarization
v. Dipole moment and its experimental determination by temperature variation method.
vi. Application of dipole moment for structure determination.
vii. Nature of wave and its characteristics such as wavelength, wave number, frequency and velocity.
viii. Rotational / Microwave spectroscopy
ix. Derivation for rotational spectra for the transition from J to J+1
x. Limitations of Rotational Spectra.
xi. Vibrational Spectra
xii. Vibrational rotational Spectra
xiii. Raman Spectroscopy
xiv. Solve the numerical problems based on this topic.

4. **Phase Rule :** After studying this topic students are expected to know-
   i. Meaning and Types of equilibrium such as true or static, metastable and Unstable equilibrium.
   ii. Meaning of phase, component and degree of freedom.
   iii. Derivation of phase rule.
   iv. Explanation of water system : Description of the curve, Phase rule relationship and typical features.
   v. Explanation of sulphur system : Description of the curve, Phase rule relationship and typical features.
   vi. Explanation of two component system curve : for silver-lead and Zinc-cadmium.

References:

1. Principles of Physical Chemistry, Fourth Edition by S.H. Marron and C. F. Pruton

2. Essentials of Physical Chemistry by B.S. Bahl, G.D.Tuli and ArunBahl Edition 2000 S. Chand and Company Ltd.

2. Essentials of Physical chemistry by BahlTuli-Revised Multicolor Edition 2009

3. Essentials of Nuclear Chemistry, H.J.Arnikar Second edition

4. Nuclear and Radiation Chemistry, Third edition

5. Quantum Chemistry second edition by Manas Chandra

6. Physical Chemistry a molecular approach by Donald A. McQuarrie , John D. Simon

Semester-IV
Course: Physical Chemistry (CH-341)

Topic	No. of Lectures
1. Electrochemical Cells	14
2. Nuclear Chemistry	12
3. Crystal Structure	12
4. Quantum Chemistry	10
Total Lectures	**48**

1. Electrochemical Cells [14 L]

Reversible and irreversible cells,EMF and its measurements,Standard cells, cell reaction and EMF,Single electrode potential and its calculation,Calculation of cellEMF,Thermodynamics of cell EMF,Types of electrodes,Classification of electrochemical cells with and without transference,Applications of EMFmeasurement-i)Solubility product of sparingly soluble salt,ii)Determination of pH,iii)Potentiometric titration

[Ref. 1 : Pages: 471-486, 492-519]

2. Nuclear Chemistry [12 L]

The atom, nucleus and outer sphere, classification of nuclides, nuclear stability and binding energy.Discovery of radioactivity, types of radioactivity, general characteristics of radioactive decay and decay kinetics,Measurements radioactivity, gaseous ion collection method, proportional and G.M. counter.

Applications of radioactivity-

Radiochemical principles in the use of tracers,

Typical applications of radioisotopes as a tracer-

i) Chemical investigations- reaction mechanism,

ii)Structure determination- phosphorus pentachloride and thiosulphate ion

iii)Age determination- by Carbon-14 dating and Uranium-Lead/ Thorium-Lead Ratio

iv) Medical applications-Assess the volume of blood in patients body, Goiter

[Ref. 3 : Pages 1, 4-15, 117-119,121-125,371-378,Ref. 4:.Pages 243-245,247-251]

3. Crystal structure [12 L]

Crystallization and fusion process,Crystallography, Crystal systems,-Properties of crystals, Crystal lattice and unit cell,-Crystal structure analysis by X ray - The Laue method and Braggs method,

- X-ray analysis of NaCl crystal system,
- Calculation of d and λ for a crystal system.

[Ref. 1 : Pages 67-85]

4. Quantum Chemistry **[10 L]**

Concept of quantization, atomic spectra (no derivation), wave particle duality, uncertainty principle, wavefunction and its interpretation, well-behaved function, Hamiltonian (energy) operator, formulation of Schrodinger equation, particle in box (1D, 2D and 3D box) (no derivations), sketching of wavefunction and probability densities for 1D box, correspondence principle, degeneracy(lifting of degeneracy), applications to conjugated systems, harmonic oscillator, wavefunction and probability densities (no derivation), zero point energy and quantum tunneling.

[Ref. 5.Quantum Chemistry second edition by Manas Chandra- Relevant pages
Ref. 6.Physical Chemistry a molecular approach by Donald A. Mc.Quarrie, John D. Simon- Relevant pages]

AIMS AND OBJECTIVES:

1. ElectrochemicalCell : After studying this topic students are expected to know-

i. What is mean by Electrochemical cell with specific example
ii. Origin of EMF of electrochemical cell.
iii. Conventions used to represent electrochemical cell.
iv. Thermodynamic conditions of reversible cell
v. Explanations of reversible and irreversible electrochemical cell with suitable example.
vi. What is mean by reference electrode?
vii. Primary and secondary reference electrode
viii. Construction, representation, working and limitation of Standard hydrogen Electrode
ix. Construction, representation and working of Calomel and Silver –Silver Chloride electrode
x. Types of electrodes
xi. Conditions of Standard Cell
xii. Construction, representation and working of Weston Standard Cell.
xiii. Measurement of EMF of electrochemical cell
xiv. Nernst Equation for theoretical determination of EMF.
xv. Thermodynamics and EMF: Relation of EMF with ΔG, ΔG°,ΔH, ΔS and equilibrium constant K of the cell reaction.
xvi. Explanation of the term liquid junction potential
xvii. Classification of electrochemical cell
xviii. Chemical cell with and without transfer
xix. Electrode and electrolytic concentration cell
xx. Concentration cell with and without transfer.
xxi. Application of EMF measurement such as pH determination, Determination of solubility and solubility product.
xxii. Potentiometric titrations: Weak acid against strong base, Titration of polybasic acids, Precipitation and Redox titrations.
xxiii. Solve the numerical problems based on this topic.

2. Nuclear Chemistry: After studying this topic students are expected to know-

i. The atom its nucleus and outer sphere.
ii. Classification of nuclides with suitable examples such as isotope, isobar, isotone and isomers
iii. Explanation of stability of nucleus through neutron to proton ratio, odd and even nature of proton and neutron, Mean binding energy.
iv. Conversion of mass into energy
v. Mass defect, Total and mean binding energy
vi. Explanation of binding energy curve.
vii. Types of decay
viii. Discovery of radioactivity
ix. Decay kinetics
x. Relation of half-life with decay constant.
xi. Unit of Radioactivity : Curie Bq
xii. Measurement of radioactivity by G.M. and proportional counter
xiii. Principle, construction and working of G.M. / Proportional counter.
xiv. Application of radioisotopes as a tracer
xv. Chemical investigation : Reaction mechanism and structure determination w.r.t PCl_5 and thiosulphate ion
xvi. Age determination- by Carbon-14 dating and Uranium-Lead/ Thorium-Lead Ratio
xvii. Medical applications-Assess the volume of blood in patients body, Goitre
xviii. Solve the numerical problems based on this topic.

3. Crystal Structure: After studying this topic students are expected to know-

i. Distinguish between crystalline and amorphous solids / anisotropic and isotropic solid
ii. Explain the term crystallography and laws of crystallography
iii. Weiss and Millers Indices
iv. Crystal system and their characteristics
v. Explain the term polymorphism /allotrophism
vi. Distance between the planes for 100, 110 and 111 type of simple, body centred and face centred cubic crystals
vii. Bragg's experiment and Derivation of ($n\lambda = 2d\sin\theta$)Bragg's equation
viii. Explanation: Structure of NaCl can be ascertained with the help of X-ray analysis.
ix. Laue's and Bragg's method.

4.Quantum Chemistry: After studying this topic students are expected to know-

i. Concept of quantization
ii. Atomic spectra
iii. Wave particle duality
iv. Uncertainty principle and its physical significance
v. Derivation of time independent Schrodinger wave equation.
vi. Wave function and its Interpretation
vii. Well behaved function
viii. Hamiltonian Operator
ix. Particle in a box (1 and 3 dimensional)
x. Degeneracy

xi. Application to conjugated systems
xii. Harmonic oscillator
xiii. Solve the numerical problems based on this topic.

References:

1.Principles of Physical Chemistry, Fourth Edition by S.H. Marron and C. F. Pruton

2. Essentials of Physical Chemistry by B.S. Bahl, G.D.Tuli and ArunBahl Edition 2000 S. Chand and Company Ltd.

2. Essentials of Physical chemistry by BahlTuli-Revised Multicolor Edition 2009

3.Essentials of Nuclear Chemistry, H.J.Arnikar Second edition

4.Nuclear and Radiation Chemistry, Third edition

5.Quantum Chemistry second editionby Manas Chandra

6.Physical Chemistry a molecular approachby Donald A. McQuarrie , John D. Simon

Physical Chemistry Practicals:CH- 347

Group A:

1. Chemical Kinetics: (Any Five):

1.To study the effect of concentration of the reactants on the rate of hydrolysis of an ester.

2.To compare the relative strength of HCl and H_2SO_4 by studying the kinetics of hydrolysis of an ester.

3.To compare the relative strength of HCl and H_2SO_4 by studying the kinetics of Inversion of cane sugar using Polarimeter.

4.To study the kinetics of iodination of acetone

5.To determine the first order velocity constant of the decomposition of hydrogen peroxide by volume determination of oxygen.

6.To determine the energy of activation of the reaction between potassium iodide and potassium persulphate.

7.To determine the order of reaction between $K_2S_2O_8$ and KI by half-life method.

2. Viscosity:

To determine the molecular weight of a high polymer by using solutions of different concentrations.

3.Adsorption

To investigate the adsorption of oxalic acid /acetic acid by activated charcoal and test the validity of Freundlich / Langmuir isotherm

4. Phenol-water system

To study the effect of addition of salt on critical solution temperature of phenol water System

5. Transport number

To determine the transport number of cation by moving boundary method.

6. Refractometry (any two)

i)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.

ii) To determine the molecular refractivity of the given liquids A, B, C and D.

iii)To determine the molar refraction of homologues methyl, ethyl and propyl alcoholand show the constancy contribution to the molar refraction by $-CH_2$ group.

Group B

1. Colorimetry (any two)

i)Determination of λ_{max} and concentration of unknown solution of $KMnO_4$ in 2 N $H2SO_4$

ii)Determination of λ_{max} and concentration of unknown solution of $CuSO_4$.

iii)To titrate Cu^{2+} ions with EDTA photometrically.

iv)To determine the indicator constant of methyl red indicator

2. Potentiometry(any three)

i)To prepare standard 0.2 M Na_2HPO and 0.1 M Citric acid solution, hence prepare four different buffer solutions using them. Determine the pka value of these and unknown solutions.

ii)To determine the concentrations of strong acid and weak acid present in the mixture by titrating with strong base.

iii)To determine the formal redox potential of Fe^{2+}/ Fe^{3+} system potentriometrically

iv)To determine the amount of NaCl in the given solution by potentiometric titration against silver nitrate.

3.pH metry (any two)

i)To determine the degree of hydrolysis of aniline hydrochloride
ii)To determine pka value of given weak acid by pH-metric titration with strong base.
iii)To determine the dissociation constant of oxalic acid by pH-metric titration with strong base
iv)To determine pH of various mixtures of sodium acetate and acetic acid in aqueous solution and hence to find the dissociation of acetic acid.

4.Radioactivity (any one)

i)To determine plateau voltage of the given G M counter.
ii)To determine the resolving time of GM counter
iii)To determine E_{max} of beta particle

5.Conductrometry (any two)

i)To determine the cell constant of the given cell using 0.01 M KCl solution and hence determine dissociation constant of a given monobasic weak acid.
ii)To estimate the amount of lead present in given solution of lead nitrate by conductometric titration with sodium sulphate.
iii)To investigate the conductometric titration of any one of the following
a)Strong acid against strong base
b)Strong acid against weak base
c)Strong base against weak acid
d)Weak acid against weak base

STRUCTURE OF PRACTICAL EXAMINATION

	Experiment	**Marks**
1.	One Experiment from Group – A	35
2.	One Experiment from Group-B	35
3.	Oral	10

References:

1. Practical Physical Chemistry, 3rd Edn. A. M. James and F. E. Prichard, Longman publication.
2. Experiments in Physical Chemistry, R. C. Das and B. Behra, Tata McGraw Hill.
3. Advanced Practical Physical Chemistry, J. B. Yadav, Goel Publishing House.
4. Advanced Experimental Chemistry, Vol-I, J. N. Gurtu and R. Kapoor, S. Chand and Company.
5. Physical Chemistry Experiments, Raghvan and Vishwanathan.

Semester-III

Course: Inorganic Chemistry (CH-332)

Topic	No. of Lectures
1. Molecular Orbital Theory	15
2. Coordination Chemistry	33
Total Lectures	**48**

1. Molecular Orbital Theory **15 L**

Limitations of Valence Bond theory(VBT), Need of Molecular orbital theory (MOT), Features of MOT, Formation of molecular orbitals(MO's) by LCAO principle, Rules of LCAO combination, Different types of combination of Atomic orbital(AO's): S-S, S-P, P-P and d-d, Non-bonding combination orbitals(formation of NBMO), M.O. Energy level diagram for homonuclear diatomic molecules, Bond order and existence of molecule from bond order, Energy (β) and magnetic behavior for following molecules or ions: H_2, H_2^+, He_2^+, Li_2, Be_2, B_2, C_2, N_2, O_2, O_2^+, O_2^-, O_2^{2-}, F_2, Ne_2,

M.O. energy level diagram, for heteronuclear diatomic molecule like CO, NO, HCl, HF.

M.O. energy level diagram, for heteronuclear triatomic molecule like CO_2, NO_2

Ref. 2 Pages 89-112, 106-117
Ref. 4 Pages 55-72

Aims and objective:

A student should:

i. Know the theories of covalent bond formation
ii. Know the assumptions and limitations of VBT
iii. Understand the need of concept of MOT
iv. Know LCAO principal and its approximation
v. Understand and show the formation of bonding and antibonding MO's
vi. Draw the shapes of s, p, d orbital
vii. Draw combinations of s-s, s-p, p-p and d-d orbital to form σ and π molecular orbitals.
viii. Give the comparison of
   a) Atomic orbital and molecular orbital
   b) BMO and ABMO
   c) Sigma and pi MO's
   d) VBT and MOT
   e) Comparison between BMO, ABMO and NBMO
ix. Draw the MO energy level diagrams for homonuclear diatomic molecules having interactions between 2s and 2p orbitals and having no interactions between 2s and 2p orbitals : H_2, H_2^+, He_2^+, Li_2, Be_2, B_2, C_2, N_2, O_2, O_2^+, O_2^-, O_2^{2-}, F_2, Ne_2,
x. Draw the shapes of molecular orbitals.
xi. Give the calculations of bond order, energy and explanation on stability of the above molecule and ions
xii. Draw the MO energy level diagrams for heteronuclear diatomic molecules: CO, NO, HCl, HF and calculations of bond order, energy and explain the stability of the molecules.

xiii. Understand the formation of BMO, ABMO and NBMO in CO_2 or NO_2 molecule and construct MO energy level diagrams for them.

2. Coordination Chemistry 33L

I. INTRODUCTION TO COORDINATION CHEMISTRY (03 L)

1. General account and meaning of the terms involved in coordination chemistry:
Coordinate bond, central metal atom or ions, ligand, double salt, complex compound, coordination number, charge on the complex ion, oxidation number of Metal ion, first and second coordination sphere.
2. Ligands: Definition, Classification, Chelates and chelating agents.
3. Formation Constant, inert and labile complexes.
4. IUPAC nomenclature of coordination compounds
5. Different geometries of coordination compounds with C.N.= 4 to C.N.=10 and examples of each geometry.

II. WERNER'S THEORY OF COORDINATION COMPOUNDS (02 L)

Assumptions of Werner's coordination theory, Werner's formulation of Coordination compounds, Physical and chemical test to support his formulation of ionizable and non-ionizable complexes, Stereoisomerism in complexes with C.N.4 and C.N. 6 to identify the correct geometrical arrangement of the complexes.

III. ISOMERISM IN COORDINATION COMPLEXES (04 L)

Definition of isomerism in complexes-Structural Isomerism and stereoisomerism,
1. Structural isomerism (ionization, hydrate, linkage, ligand, coordination position and polymerization isomers)
2. Stereoisomerism and its types-Geometrical isomerism and optical isomerism.

IV. SIDGWICK THEORY (02 L)

Concept of Sidgwick's model, Scheme of arrow indication for M-L bond suggested by Sidgwick, Effective Atomic Number rule (EAN), Calculations of EAN value for different complexes and stability of complexes, Advantages and Drawbacks of Sidgwick's theory.

V. PAULING'S VALENCE BOND THEORY (06 L)

Introduction of Valence Bond Theory (VBT), Need of concept of hybridization, Aspects of VBT, Assumptions, VB representation of tetrahedral, square planer, trigonalbipyramidal and octahedral complexes with examples, Inner and outer orbital complexes, Electro neutrality principle, Multiple bonding(dπ-pπ and dπ-dπ), Limitations of VBT.

VI. CRYSTAL FIELD THEORY (10 L)

Introduction and need of Crystal Field Theory(CFT), Assumptions, Shapes and degeneracy of d orbital, Splitting of d-orbitals, Application of CFT to octahedral complexes, pairing energy(P) and distribution of electrons in e_g and t_{2g} level, calculation of magnetic moment using spin-only formula, Crystal Field Stabilization Energy (CFSE), calculation of CFSE in weak oh field and strong oh field complexes, Evidence for CFSE, Interpretation of spectra of complexes, calculation of 10 Dq and factors affecting magnitude of 10Dq, d-d transitions and colour of the complexes, Jahn-Teller distortion theorem for octahedral complexes and its illustration, CFT of tetrahedral and square planar

complexes, calculations of CFSE, Spectrochemical series, Nephelauxatic effect and Nephelauxetic series, Limitations of CFT, modified CFT (LFT), Problems related to calculation of 10 Dq, CFSE and spin only magnetic moment for octahedral, tetrahedral & square planar complexes. (i.e. for high spin & low spin complexes)

VII. MOLECULAR ORBITAL THEORY OF COORDINATION COMPLEX (06 L)

Introduction, 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, Charge transfer spectra, Comparison of VBT, CFT, and MOT.

Ref. 2 Pages 194 -236
Ref. 8 Relevant Pages
Ref. 9 Relevant Pages

Aims and objective

A student should:

i. Know the meaning of various terms involved in coordination chemistry.
ii. Know the different types of Ligands.
iii. Understand the chelating agents, chelate and stability of chelates and complexes.
iv. Calculate the charge on complex ion and the oxidation number.
v. Be able to give the IUPAC name the co-ordination compound.
vi. Know the application of co- ordination compounds in biology and chemistry.
vii. Be able to understand the Werner's formulation of complexes and identify the ionizable ions.
viii. Be able to distinguish between ionizable and non-ionizablevalencies with suitable examples.
ix. Give the suitable physical and chemical test for identification of number and types of ionizable ions.
x. Be able to draw the geometrical and optical isomerism of complexes.
xi. Choose the correct geometry for complexes with C.N. 4 and C.N. 6 with the help of stereoisomerism.
xii. Be able to define and explain isomerism in complexes.
xiii. Be able to explain various types of isomerism.
xiv. Comment on the stereoisomerism in complexes with C.N. 4 and C. N. 6.
xv. Define EAN rule and calculate EAN value of the complexes.
xvi. Comment on EAN value and stability of complexes.
xvii. Know the merits and the demerits of Sidgwick's theory.
xviii. Be able to explain the need of concept of hybridization.
xix. Explain the VB representation of tetrahedral, square planar, trigonalbipyramidal and octahedral complexes.
xx. Be able to identify which d-orbitals are involved in hybridization during formation of complexes with different geometries such as tetrahedral, square planar, trigonalbipyramidal and octahedral.
xxi. Be able to explain structure and magnetic behaviour of the complexes.
xxii. Be able to identify the high spin and low spin complexes.
xxiii. Be able to identify inner orbital and outer orbital complexes.
xxiv. Explain elctroneutrality principle and different types of pi bonding.
xxv. Know the limitations of VBT.
xxvi. Know the shapes of d-orbitals and degeneracy of d-orbitals.

xxvii. Know the assumptions of CFT.
xxviii. Understand how splitting of d-orbitals occurs when ligand approaches.
xxix. Be able to draw crystal filled splitting diagrams of d orbital of metal ion in octahedral, tetrahedral, square planer of tetragonal ligand field.
xxx. Interpret the spectra of complexes and calculate the 10 Dq.
xxxi. Understand the factors affecting magnitude of 10 Dq.
xxxii. Be able to find high spin and low spin complexes when 10 Dq and pairing energy are given.
xxxiii. Be able to explain d-d transitions and colour of the complexes.
xxxiv. Know the conditions under which Jahn-Teller distortion occurs.
xxxv. Explain, why Jahn-Teller distortion should occur in Oh complexes?
xxxvi. Be able to explain Nephelauxetic effect towards covalent bonding.
xxxvii. Explain MOT of Octahedral complexes with sigma bonding.
xxxviii. Be able to explain Charge Transfer Spectra.
xxxix. Be able to compare the different approaches to bonding in Coordination compounds.

Reference Books:

Ref. 1 Introduction to Electrochemistry by Glasstone - 2nd edition.
Ref. 2 Concise Inorganic Chemistry by J.D. Lee - 5th edition.
Ref. 3 Inorganic Chemistry, - D.F. Shiver & P.W. Atkins- C.H.Longford ELBS - 2nd edition.
Ref. 4 Basic Inorganic Chemistry, - F.A. Cotton and G. Wilkinson, Wiley Eastern Ltd 1992.
Ref .5 Concept and Model of Inorganic Chemistry by Douglas – Mc Daniels - 3rd edition.
Ref. 6 Chemistry by Raymond Chang - 5th edition
Ref. 7 New Guide to Modern Valence Theory by G.I. Brown - 3rd edition
Ref. 8 Co-ordination Compounds by Baselo and Pearson.
Ref. 9 Theoretical Inorganic Chemistry by Day and Selbin.
Ref.10 Inorganic Chemistry by A. G. Sharpe - 3rd Edition.
Ref.11 Coordination Chemistry by A. K. De.

Semester-IV
Course: Inorganic Chemistry (CH-342)

Topic	No. of Lectures
1. Chemistry of f-block element	08
2. Metals Semiconductors and Superconductors	10
3. Ionic Solids	10
4. Homogeneous Catalysis	06
5. Heterogeneous Catalysis	08
6. Bioinorganic Chemistry	06
Total Lectures	**48**

1. Chemistry of f- block elements (08 L)

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, Occurrence and separation (Group/ Individual) by modern methods (ion exchange and solvent extraction method), Lanthanide contraction & its effect on chemistry of Lanthanides and post-lanthanide elements, applications of lanthanides

II. Actinides

Position in periodic table, Name and electronic Configuration of actinides, Oxidation States, Occurrence, and general methods of preparation of transuranic elements [viz., a) Neutron Bombardment, b) Accelerated projectile bombardment and c) Heavy ion bombardment], Nuclear Fuels-Nuclear Fusion fuels & nuclear fission fuels, IUPAC nomenclature system for super heavy elements with atomic no. (z) greater than100, Comparison between Lanthanides and Actinides.

Ref. 2 Pages 859-863, 865-866, 874 – 875, 879-886, 891-893, 898-900

Aims and objective

A student should know:

a. The meaning of term f-block elements, Inner transition elements, lanthanides, actinides.
b. Electronic configuration of lanthanides and actinides.
c. Oxidation states of lanthanides and actinides and common oxidation states.
d. Separation lanthanides by modern methods.
e. Lanthanide contraction and effects of lanthanide contraction on post-lanthanides.
f. Use of lanthanide elements in different industries.
g. Transuranic elements.
h. Preparation methods of transuranic elements.
i. Nuclear fuels and their applications.
j. Why transuranic elements are called as the synthetic elements?
k. IUPAC nomenclature for super heavy elements with atomic no. 100 onwards.

2. Metals, semiconductors and Super conductors (10 L)

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, Super conductivity- Discovery, Property, Models structure and superconductivity, Applications of superconductors,

Ref. 7 Pages 209-221
Ref. 6 Related Pages

Aims and objective
A student should know:

a. The meaning of metal & semiconductor.
b. The difference between metal, semiconductor and insulator.
c. Metallic bond on the basis of band theory.
d. The energy band and energy curve.
e. Draw n (E) & N (E) curves.
f. Explain the electrical conductivity of metals with respect to valence electrons.
g. Explain the effect of temperature and impurity on conductivity of metals and semiconductors.
h. Intrinsic and extrinsic semiconductor.
i. The term valance band and conduction band.
j. n and p type of semiconductors.
k. Non-stoichiometry and semi conductivity.
l. Insulators on the basis of band theory.
m. The difference between Na, Mg, and Al in terms of valence electrons and conductivity.
n. Meaning of super conductors and their structure.
o. Discovery and applications of superconductors.

3. Ionic Solids (06 L)

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.

Ref. 2 Pages 32-61
Ref. 5 Pages 102-127
Ref. 7 Pages 55-62

Aims and objectives
A student should:

i. Know the nature of solids.
ii. Know the crystal structures of solids.
iii. Draw the simple cubic, BCC and FCC structures.
iv. Identify the C.N. of an ion in ionic solid.
v. Identify the type of void.
vi. Know the effect of radius ratio in determining the crystal structure.
vii. Be able to define Pauling's univalent radius and crystal radius.

viii. Be able to solve simple problems based on Pauling's univalent radii and crystal radii.
ix. Know how to draw Born-Haber cycle.
x. Be able to solve simple problems based on Born- Haber cycle.
xi. Know the defects in Ionic solids.
xii. Be able to differentiate between the defects.

4. Homogeneous Catalysis (06 L)

Definition, types of homogeneous catalysts, Essential properties of homogeneous catalysts, Catalytic Reactions such as:

a. Wilkinson's Catalysis
b. Zeigler Natta Catalysis
c. Monsanto acetic acid synthesis

Ref. 3 Related Pages
Ref. 6 Related Pages
Ref. 13 Pages 650-652 and 656-661

Aims and objectives

A student should:

i. Define the homogeneous catalysis.
ii. Give examples of homogeneous catalysts.
iii. Understand the essential properties of homogeneous catalysts-Give the catalytic reactions for Wilkinson's Catalysis, Zeigler Natta Catalysis, Monsanto acetic acid synthesis
iv. Give the brief account of homogeneous catalysis.

5. Heterogeneous Catalysis (08 L)

Definition, types of heterogeneous catalysts-metals, semiconductors, solid acid catalysts and supported catalysts, Essential properties of heterogeneous catalysts, Catalytic Reactions such as:

a. Oxidation- i. Synthesis of terephthalic acid from xylene using ZSM-5
   ii. Synthesis of benzoic acid from toluene using $KMnO_4$
b. Reduction- i. Hydrogenation of alkene to alkane using Raney Ni catalyst.
   ii. Synthesis of p-aminophenol from nitrobenzene using Pd/C catalyst.
c. Cyclization- Benzimidazole synthesis using o-phenenediamine and benzaldehyde by acidic support or clay-solid support, amberlist or NH_4Cl.
d. Biodiesel Synthesis- using heteropolyacid catalyst- Transesterification using phosphomolybdic or phosphotungstic acid.

Ref. 5 Related Pages
Ref. 11 Related Pages
Ref. 13 Related Pages

Aims and objectives

A student should:

i. Define the heterogeneous catalyst and heterogeneous catalysis.
ii. Give examples of heterogeneous catalysts.
iii. Understand the essential properties of heterogeneous catalysts.
iv. Give the catalytic reactions for oxidation, reduction and cyclization processes.
v. Give the brief account of biodiesel synthesis using heterogeneous catalysis.
vi. Enlist the catalysts used for benzimidazole synthesis.

vii. Understand the catalytic reactions used in industries around.

6. Bioinorganic Chemistry (06 L)

I. Introduction, Role of metals in bioinorganic chemistry-

a. Classification as enzymatic and non-enzymatic metals,
Enzymatic redox metals such as Cu (SOD) and enzymatic non redox metals such as Zn (Hydrolase).
b. Role of metal ions in non-enzymatic process- Na, K, Ca, Mg (one example of each and brief discussion).
c. 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.

IV. Bioinorganic Chemistry of Co: Vitamin-B_{12}, its structure and function.

Ref. 3 Pages 782-806
Ref. 2 Pages 353, 775, 779, 796-797
Ref. 12 Pages 1-13, 24, 285-290

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.

Reference Books:

Ref. 1 Introduction to Electrochemistry by Glasstone - 2nd edition.
Ref. 2 Concise Inorganic Chemistry by J.D. Lee - 5th edition.
Ref. 3 Inorganic Chemistry, - D.F. Shiver & P.W. Atkins- C.H.Longford ELBS - 2nd edition.
Ref. 4 Basic Inorganic Chemistry, - F.A. Cotton and G. Wilkinson, Wiely Eastern Ltd 1992.
Ref .5 Concept and Model of Inorganic Chemistry by Douglas – Mc Daniels - 3rd edition.
Ref. 6 Chemistry by Raymond Chang - 5th edition
Ref. 7 New Guide to Modern Valence Theory by G.I. Brown - 3rd edition
Ref. 8 Co-ordination Compounds by Baselo and Pearson
Ref. 9 Theoretical Inorganic Chemistry by Day and Selbin
Ref.10 Inorganic Chemistry by A. G. Sharpe - 3rd Edition
Ref.11 Heterogenous Catalysis by D.K Chakrabarty and B. Vishwanathan, New Age Intl. Publishers, 1st Edn.
Ref. 12 Principles of Bioinorganic Chemistry by S. J. Lippard and J. M. Berg, Panima Publishing Corporation, 1st Edn.
Ref. 13 Inorganic Chemistry by J.E. Huheey, 4th Edn, Pearson Education.

CH-348 - INORGANIC CHEMISTRY PRACTICALS

A) Gravimetric estimations (Any 3)

1. Fe as Fe_2O_3
2. Nickel as Ni – DMG
3. Al as Aluminum oxide
4. Gravimetric estimation of Ba as $BaSO_4$ using homogeneous precipitation method.

B) Volumetric Estimations (Any 4)

1. Mn by Volhard's method
2. Estimation of NO_2^- by using $KMnO_4$.
3. Estimation of % purity of given sample of Sodium Chloride
4. Analysis of Brass-Estimation of copper by Iodometry
5. Fertilizer analysis (PO_4^{3-})

C) Inorganic preparations (Any 4)

1. Preparation of Hexamminenickel(II), $[Ni(NH_3)_6]^{2+}$.
2. Preparation of Potassium Trioxalatoferrate (III), $K_3[Fe(C_2O_4)_3]$.
3. Preparation of Tetraamminecopper (II) suplhate, $[Cu(NH_3)_4]SO_4$.
4. Preparation of Manganese (III) acetylacetonate $[Mn(acac)_3]$.
5. Preparation of Tris(Thiourea)Copper (I) Chloride $[Cu(Thiourea)_3]Cl$.

D) Colorimetric Estimations (Any 2)

1. Iron by thiocyanate method.
2. Cobalt by using R-nitroso salt method.
3. Titanium by H_2O_2.

E) Separation of binary mixture of cations by Column Chromatography (3 mixtures)

(One mixture should be colorless, Zn + Al, Zn + Mg)

OR

E) Flame Photometry (Any 3)

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.

F) Qualitative Analysis (4 mixtures including Borates and Phosphates)

G) Visit to a chemical industry and report writing is compulsory.

Reference Books: Ref. 1 General Chemistry Experiment – Anil J Elias (University press).
Ref. 2 Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.
Ref. 3 Quantitative Chemical Analysis S. Sahay (S. Chand & Co.).
Ref. 4 Quantitative Analysis R.A. Day, Underwood (Prentice Hall).
Ref. 5 Practical Chemistry K.K. Sharma, D. S. Sharma (Vikas Publication).
Ref. 6 Vogel's Textbook of Quantitative Chemical Analysis.
Ref. 7 Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST.
Ref. 8"Experimental Methods in Inorganic Chemistry." Tanaka, J. and Suib, S.L., Prentice Hall, New Jersey, 1999.

STRUCTURE OF PRACTICAL EXAMINATION

Experiment		**Marks**
Q.1.	Qualitative analysis OR Gravimetric Experiment*	**35**
Q.2.	Volumetric Experiment (25 Marks) Preparation (10 marks) OR Flame Photometry (20 marks) Preparation (10 marks) OR Column Chromatography (20 marks) Preparation (10 marks) OR Colorimetric Estimation (25 Marks) Preparation (10 marks)	**35**
Q.3.	Oral	**10**

*Minimum 50 % students of each batch should be allotted Gravimetric Estimation.

Semester III
Course: Organic Chemistry (CH-333)

Topic	No. of Lectures
1. Strength of organic acids and bases	03
2. Stereochemistry of disubstituted cyclohexane	06
3. Nucleophilic substitution at aliphatic Carbon	08
4. Reactions of unsaturated hydrocarbons and carbon oxygen double bond	15
5. Elimination Reactions	06
6. Aromatic Electrophilic and Nucleophilic Substitution Reactions	10
Total Lectures	**48**

1. Strength of organic acids and bases **(03)** Introduction, pk_a, origin of acidity, influence of solvent, simple aliphatic saturated and unsaturated acids, substituted aliphatic acid, phenols, aromatic carboxylic acids, pk_a and temperature, pk_b, aliphatic and aromatic bases, heterocyclic bases, acid base catalysis.

Aimsand objectives: Students should know –

1. Definition and types of organic acid and base
2. The pka and pkb concepts
3. Effect of temperature on pk_a/pk_b
4. Comparison between strengths of acids/bases
5. What is acid-base catalysis

Ref.8 (53-75), Ref. 7 Relevant pages.

2. Stereochemistry of disubstituted cyclohexane **(06)**

Introduction, 1,1-alkyl disubstituted cyclohexane; Dimethyl cyclohexane 1,2; 1,3 and 1,4. Geometrical isomerism, Optical isomerism, stability of conformation, energy calculations.

Aimsand objectives: Students should learn –

1. To draw different types of disubstituted cyclohexane in Chair form
2. To distinguish between geometrical and optical isomerism
3. Stability, energy calculations with potential energy diagram and optical activity of these conformers.

Ref. 1 Relevant pages, Ref. 3 (204-214),

3. Nucleophilic substitution at aliphatic Carbon **(08)**

Introduction, Nucleophile and leaving groups, Mechanism of nucleophilic substitution. The S_N1 reaction: Kinetics, mechanism and stereochemistry (Racemization), stability of carbocation. The S_N2 reaction: Kinetics, mechanism & stereochemistry (inversion). How to know whether a given reaction will follow S_N1 or S_N2 mechanism.Comparison of S_N1 & S_N2 reactions.S_Ni reaction and mechanism.

Aimsand objectives: Students should understood –

1. Definition and type of nucleophiles and leaving groups
2. Different types of nucleophilic substitution reactions
3. Definition of inversion and racemization
4. The kinetics, mechanism & stereochemistry of these reactions
5. Whether a given reaction follows $_{SN}1$ or $_{SN}2$ mechanism?
6. The comparison between S_N1 & S_N2 reactions
7. An S_Ni mechanism in presence and absence of pyridine
8. To predict product/s or supply the reagent/s for these reactions

Ref.1. Pages 172-203 and 208 to 210 Ref.8.Relevant pages

4. Reactions of unsaturated hydrocarbons and carbon oxygen double bond (15)

a) Reaction of Carbon-Carbon double bond: Introduction, Mechanism of electrophilic addition to C=C bond. Orientation & reactivity, Rearrangements, (Support for formation of carbocation). Addition of hydrohalogen, Anti Markownikoff's addition (peroxide effect) with mechanism, Addition of halogens (dl pairs and meso isomers), hypohalous acids (HOX), Hydroxylation (Mechanism of cis and trans 1,2-diols). Hydroboration- Oxidation (Formation of alcohol), Hydrogenation (Formation of alkane), Ozonolysis (formation of aldehydes & ketones)

Ref.1. (Pages 317-323,327-343,346-355,357,360)

b) Reactions of Carbon –Carbon triple bond: Addition of hydrogen, halogens, halogen acids, water and formation of metal acetylides and its application.

Ref.1 (Pages 431-433)

c) Reactions of Carbon –Oxygen double bond:

Introduction, Structure of carbonyl group, reactivity of carbonyl group, addition of Hydrogen cyanide, alcohols, thiols, water, ammonia derivatives, Cannizzaro and Reformaski reactions with mechanism.

Aimsand objectives: Students should know –

1. Different types of carbon-carbon unsaturated compounds
2. Orientation / rules in addition reactions
3. The structure of carbonyl group
4. Reactivity concept
5. Correct mechanism of addition reactions using different reagents
6. Types of some known addition reactions
7. To predict product/s or supply the reagent/s for such reactions.

Ref.1.Relevant pages

5. Elimination Reactions (06)

Introduction; 1,1; 1,2 elimination,E1, E2 and E1cB mechanism with evidences, Hoffmann and Saytzeff's elimination, reactivity effect of structure, attacking and leaving groups.

Aimsand objectives: Students should learn –

1. Definition and types of elimination reactions
2. Different types of bases and leaving groups

3. Statement of Hoffmann and Saytzeff rule
4. The evidences, mechanism & stereochemical aspects of these reactions
5. Whether a given reaction follows E1, E2 or E1cB mechanism?
6. Comparison between E1 & E2 reactions
7. The effect of structure, attacking and leaving group on reactivity of such reactions
8. To predict product/s or supply the reagent/s for these reactions

Ref. 1. (Pages 290-310)

Ref. 2.Relevant Pages.

6. Aromatic Electrophilic and Nucleophilic substitution reactions (10)

Introduction, arenium ion mechanism, Effect of substituent group (Orientation, o/p directing and meta directing groups). Classification of substituent groups (activating and deactivating groups) Mechanism of – Nitration, Sulfonation, Haloganation, Fridel-Crafts reactions, Diazo Coupling reactions, Ipso-substitution.Addition-elimination (S_NAr), S_N1, Elimination-addition (Benzyne) S_NR1 reactions, reactivity.

Aimsand objectives: Students should understood –

1. Definition and types of aromatic substitution reactions
2. Classification of directing groups
3. What is an arenium ion and Ipso substitution?
4. The evidences, reactivity and mechanism of these reactions
5. Whether a given reaction follows addition-Elimination or Elimination-addition mechanism?
6. To predict product/s or supply the reagent/s for these reactions

Ref 1-(Pages 517-544, 666-67), Ref 7 and 8- Relevant Pages.

Reference Books:

1) Organic Chemistry by Morrison and Boyd 6thEdn
2) Organic Chemistry by Cram and Hammond.
3) Stereochemistry of Organic compounds by Eliel Tata McGraw Hill 1989.
4) Organic Chemistry by John McMurryVthEdn. 1999
5) Organic Chemistry by Graham Solomans
6) Organic Chemistry by I.L.FinarVol.IIVthEdn.
7) Organic Chemistry by Clayden, Greeves, Warren and Wothers (Oxferd Press)
8) A guide book to reaction Mechanism by Peter Sykes VI thEdn.

Semester IV
Course: Organic Chemistry (CH-343)

Topic	No. of Lectures
1. Carbanions and their reactions	06
2. Retrosynthetic analysis and applications	05
3. Rearrangement reactions	06
4. Spectroscopic methods in structure determination of Organic compounds	24
5. Natural Products	07
Total Lectures	**48**

1. Carbanions and their reactions (06)

Introduction, Formation and stability of Carbanion. Reactions involving carbanions and their mechanisms: Aldol, Claisen, Dieckmann and Perkin condensations. Synthesis and Synthetic applications of Malonic ester, Acetoacetic ester and Wittig reagent.

Aimsand objectives: Students should know –

1. Definition and formation of carbanions
2. Possible mechanism of some known name reactions involving carbanions
3. Synthetic applications some reagents
4. To predict product/s or supply the reagent/s for these reactions

Ref. 2 (270-299).

2. Retrosynthetic analysis and applications (05)

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.

Aimsand objectives: Students should learn –

1. Meaning of terms Disconnection, Synthons, Synthetic equivalence, Functional Group Interconversion, Target Molecule
2. What is retrosynthesis?
3. Various steps involved in the synthesis of some molecules (detailed mechanism is not expected)

Ref.3 Relevant pages

Ref.4. Relevant pages

3. Rearrangement reactions (06)

Introduction, Mechanism of rearrangement reaction involving carbocation, nitriene and oxonium ion intermediate.Beckmann, Bayer-Villiger, Pinacol-pincolone, Curtis, Favorski, Claisen rearrangement.

Aimsand objectives: Students should understood –

1. What is rearrangement reaction?
2. Different types of intermediate in rearrangement reactions?
3. To write mechanism of some named rearrangement reactions

Ref. 8. (Pages 86-90,105,112,122,158)
Ref. 6.Relevant Pages.

4. Spectroscopic methods in structure determination of Organic compounds (24)

Introduction, meaning of spectroscopy, nature of electromagnetic radiation, wave length, frequency, energy, amplitude, wave number, and their relationship, different units of measurement of wavelength frequency, different regions of electromagnetic radiations. Interaction of radiation with matter.Excitation of molecules with different energy levels, such as rotational, vibrational and electronic level. Types of spectroscopy and advantages of spectroscopic methods.

Aimsand objectives: Students should know –

1. What is Spectroscopy?
2. Different regions of electromagnetic radiations
3. Various terms used in spectroscopy
4. What is the interaction of radiation with matter
5. Types of energy levels with diagram
6. Brief idea about the advantages of spectroscopic methods

Ref-5.(Pages 1-3, 7-11), Ref. 9 and 10 Relevant pages.

A) Ultra Violet Spectroscopy

Introduction, nature of UV, Beer's law, absorption of UV radiation by organic molecule leading to different excitation. Terms used in UV Spectroscopy- Chromophore, Auxochrome, Bathochromic shift(Red shift), hypsochromic shift(Blue shift), hyperchromic and hypochromic effect. Effect of conjugation on position of UV band. Calculation of λmax by Woodward and Fisher rules for dienes and enone systems, Colour and visible spectrum, Applications of UV Spectroscopy- Determination of structure, Determination of stereo chemistry (Cis and trans)

Aimsand objectives: Students should learn –

1. What is UV Spectroscopy and Beer's law?
2. Different types of electronic excitations
3. Various terms used in UV spectroscopy
4. What is the effect of conjugation on UV band
5. To calculation of λmax for dienes and enone systems
6. Define colour?
7. What is the range of vision region ?
8. Applications of UV Spectroscopy

Ref-5. (Pages 13-15, 18-38)

B) Infra red Spectroscopy

Introduction, Principle of IR Spectroscopy, Fundamental modes of vibrations (3N-6, 3N-5) Types of vibrations (Stretching and bending), Hooks law, Condition for absorption of IR radiations, vibration of diatomic molecules. Regions of IR Spectrum: fundamental group region, finger print region aromatic

region, Characteristic of IR absorption of functional groups: Alkanes, alkenes, alkynes, alcohol, ethers, alkyl-halides, carbonyl compounds (-CHO, C=O,-COOR-COOH), amines, amides and Aromatic Compounds and their substitution Patterns. Factors affecting on IR absorption: Inductive effect, resonance effect, hydrogen bonding. Application of IR Spectroscopy in determination of structure, chemical reaction and hydrogen bonding.

Aimsand objectives: Students should understood–

1. What is IR Spectroscopy?
2. To calculate fundamental modes of vibrations for a given molecule
3. Which factors affect IR band position?
4. To distinguish compounds by this spectroscopic method
5. To determine structure and follow the course of reaction by IR spectrum

Ref-5.(Pages 46-51, 53, 54,72-81, 86)

C) PMR Spectroscopy

Introduction, Principles of PMR Spectroscopy, Magnetic and nonmagnetic nuclei, Precessional motion of nuclei without mathematical details, Nuclear resonance, chemical shift, shielding, & deshielding effect. Measurement of chemical shift, delta and Tau-scales. TMS as reference and its advantages, peak area, integration, spin-spin coupling, coupling constants, *J*-value (Only first order coupling be discussed)

Aimsand objectives: Students should know–

1. What is the principle of PMR?
2. Various terms used in PMR spectroscopy.
3. Why TMS is used as a reference compound?
4. To distinguish compounds by PMR

Ref-5. (Pages 95-98, 106-108)

D) Problems based on U.V., I.R. and PMR.

Ref-1, 9 and 10.

5) Natural Products (07)

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 Ephedrin by Nagi.

Aimsand objectives: Students should learn–

1. What are terpenoids and alkaloids?
2. Various methods of isolation/extraction of these natural products.
3. Synthesis of Citral and Ephedrin by Barbier- Bouveault and Nagi methods, respectively.
4. To determine the structure of above compounds by chemical methods.

Ref-6 (1437-1440) Ref.7.Relevant Pages.

Reference Books :

1. Organic Chemistry by Morrison and Boyd. VIthEdn.
2. A guide book to reaction mechanism by Peter Sykes VIthEdn.
3. Designing organic Synthesis by Stuart Warren 1983
4. Organic Chemistry by Cram and Hammond
5. Absorption Spectroscopy of Organic Molecules by V. M. Parikh 1974
6. Organic Chemistry by Clayden, Greeves, Warren and Wothers
7. Organic Chemistry by I. L. Finar Vol. II VthEdn.
8. Reactions, Rearrangements and reagents by S. N. Sanyal
9. Introduction Spectroscopy by Pavia
10. Spectroscopic identification of organic molecules by Silverstein

Organic Chemistry Practical (CH-349)

A) Separation of Binary Mixtures and Qualitative Analysis (8 Mixtures)

Solid-Solid (4 Mixtures), Solid-Liquid (2 Mixtures), Liquid-Liquid (2 Mixtures).

At least one mixture from each of the following should be given-Acid-Base, Acid-Phenol, Acid-Neutral, Phenol-Base, Phenol-Neutral, Base-Neutral and Neutral- Neutral.

Name and structure of the separated components of the binary mixture is not necessary. Students are expected to record the- Type, Separation of mixture, Preliminary tests, Physical constants, Elements and Functional groups only. The purified samples of the separated components should be submitted. Separation and qualitative analysis of the binary Mixtures should be carried out on micro scale using micro scale kits.

B) Organic Estimations (Four)

i. Estimation of acetamide.

ii. Estimation of Glucose.

iii. Estimation of Ethyl benzoate.

iv. Determination of Molecular weight of Monobasic acids by Volumetric Methods.

v. Determination of Molecular weight of Dibasic acids by Volumetric Methods.

C) Organic Preparations (Eight)

Preparation of: Adipic acid from cyclohexanone (Oxidation by Con. HNO_3)

Benzoquinone from Hydroquinone (Oxidation by $KBrO_3/K_2CrO_3$)

P-nitroacetanilide from Acetanilide (Nitration)

B-Napthyl ether from B-napthol (Methylation by DMS, NaOH)

Hippuric acid from Glycine (Benzoylation)

P-Iodonitrobenzene from P-Nitroaniline (Sandmeyer Reaction)

Benzoic acid from Ethyl benzoate (Ester hydrolysis)

P-Bromacetanilide from Acetanilide (Bromination)

Paraacetomol from P-Hydroxyaniline (Acetylation)

Ethylbenzene from Acetophenone (Wolff Kishner reduction)

The preparation should be carried out on small scale. The starting compound should not be given more than one gm. Double burette method should be used for titration. Monitoring of the reaction and purification should be carried out by recrystallization and purity of the product in preparation should be checked by physical constant(M.P/B.P.) determination and thin layer Chromatography (TLC) with proper selection of the solvent system.

Reference Books

1) Practical Organic Chemistry by – A.I. Vogal.
2) Practical Organic Chemistry by – O.P. Agarwal.

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STRUCTURE OF ANNUAL PRACTICAL EXAMINATION

1. Binary Mixture separation and qualitative Analysis 40 Marks
2. Organic Estimation/ Preparation 30 Marks
3. Oral 10 Marks

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Semester-III

Course: Analytical Chemistry (CH-334)

Sr. No.	Topic	No. of Lectures
1	Gravimetric Analysis	12
2	Thermal methods of analysis	06
3	Spectrophotometry	10
4	Polarography	08
5	Atomic Absorption Spectroscopy	06
6	Flame Emission Spectroscopy	06
Total Lectures		**48**

1. Gravimetric Analysis (12 L)

Common ion effect and solubility product principles, Conditions for good precipitation,Factors affecting precipitation like acid, temperature, nature of solvent,Super saturation and precipitation formation,Precipitation from homogeneous solution and examples, Co-precipitation, post-precipitation and remedies for their minimization, Washing of precipitate and ignition of precipitate,Brief idea about method of filtration and drying of precipitate, Introduction to electrogravimetry: principle, applications, electrolytic separations of Cu and Ni, Numerical problems only on gravimetric analysis.

Ref. 1. Pg. 22-28, 30-33, 95, 107-114, 169-171, 403-404, 407-415
Ref. 3. Pg. 527-532

Aims and Objectives

Student should know,

1. Principles of common ion effect and solubility product
2. Formation of complex ion
3. Factors affecting on solubility of precipitation
4. Phenomenon of super saturation and precipitation formation
5. Meaning of co-precipitation and post precipitation
6. Choice of liquid for washing the precipitate
7. Precautions during filtration, drying and ignition of precipitate
8. Conceptual understanding of electrogravimetric principle
9. Numerical Problems

2. Thermal methods of analysis (06L)

Principle of thermal analysis, classification of thermal techniques, Principle, instrumentation and applications of TGA and DTA, factors affecting the thermal analysis, numerical problem.

Aims and Objectives

Student should know,

1. Methods of thermo gravimetric analysis

2. Principles of TGA and DTA
3. Types of TGA
4. Relation between TGA and DTA
5. Thermal equation of TGA
6. Different factors affecting TGA curve
7. Determination of calcium oxalate precursor
8. Applications of TGA, DTA and DSC

Ref. 1. Pg. 515-527,531-537

Ref. 6 Pg. 732-737

3. Spectrophotometry (10 L)

Introduction, Electromagnetic spectrum, Interaction of electromagnetic radiations with the matter, Mathematical Statement and derivation of Lambert's Law and Beer's Law, Terminology involved in spectrophotometric analysis, Instrumentation of single beamcolorimeter, Instrumentation of single and double beam spectrophotometer, Principle of additivity of absorbance and simultaneous determination, Spectrophotometric Titrations, Experimental Applications-Structure of organic compounds, Structure of complexes, Numerical Problems

Ref. 1 Pg. 693-705

Ref. 3 Pg. 144-153, 157-160, 170-174

Aims and Objectives

Student should know,
1. Principles of Spectrophotometric analysis and properties of electromagnetic radiations
2. Different Terms like absorbance, transmittance, and molar absorptivity
3. Mathematical Statement and derivation of Lambert's Law and Beer's Law
4. Different wavelength selectors and their importance
5. Instrumentation and working of single and double beam spectrophotometer
6. Additivity Principle
7. Different methods of color comparators
8. Applications
9. Numerical Problems

4. Polarography (08 L)

Introduction to voltammetric methods of analysis, Principles of polarographic analysis, Dropping Mercury Electrode, Instrument and working of polarographic apparatus, Ilkovic equation and quantitative analysis, Polarogram and chemical analysis, Analysis of mixture of cations, Factors affecting polarographic wave, Quantitative Applications, Numerical Problems

Ref.6. 691-734

Aims and Objectives

Student should know,
1. Voltammetry and polarography as an analytical tool
2. Construction, working, advantages and disadvantages of DME

3. Different terms involved in Ilkovic equation
4. Determination of Zn and Cd from the mixture
5. Significance of the different terms involved.
6. Need of removal of dissolved oxygen from analyte solution
4. Applications and numerical problems

5. Atomic Absorption Spectroscopy (06 L)

Introduction and theory of atomic absorption spectroscopy, Instrumentation of single beam atomic absorption Spectrophotometer, Measurement of absorbance of atomic species by AAS, Spectral and Chemical Interferences, Qualitative and Quantitative Applications of AAS. Numerical Problems.

Ref. 3. Pg. 321-342

Aims and Objectives
Student should know,
1. Atomic absorption spectroscopy as an analytical tool
2. Measurement of absorbance of atoms by AAS.
3. Interferences in atomic absorption spectroscopy
4. Applications and numerical problems

6. Flame Emission Spectroscopy (06 L)

Introduction and theory of atomic emission spectroscopy, Instrumentation of single beam flame emission spectrophotometer, Measurement of emission of atomic species, Interferences in emission spectroscopy, Methods of analysis- calibration curve method, Standard addition method, and internal, standard method, Qualitative and Quantitative Applications of FES, Numerical Problems.

Ref. 3. Pg. 321-322, 336-341, 364-370, 372-376

Aims and Objectives
Student should know,
1. Emission spectroscopy as an analytical tool
2. Measurement of emission of atomic species
3. Different methods of analysis
4. Application and numerical problems.

References
Ref.1 Textbook of Quantitative Chemical Analysis- 3rd Edition, A. I. Vogel
Ref.2 Principles of Physical Chemistry 4th edition – Prutton and Marron
Ref.3 Instrumental Methods of Chemical Analysis- Chatwal and Anand
Ref.4 Basic Concept of Analytical Chemistry-2nd edition S.M. Khopkar
Ref.5 Vogel's textbook of Quantitative Inorganic Analysis-4th edition
Besset Denney, Jaffrey, Mendham
Ref.6 Instrumental Methods of Chemical Analysis- 6th edition
Willard, Merritt, Dean and Settle
Ref.7 Analytical Chemistry by Skoog
Ref.8 Introduction to Instrumental Analysis- R.D. Braun
Ref.9 Instrumental methods of Chemical Analysis-Willard, Dean & Merrit-6th Edition

Semester-IV

Course: Analytical Chemistry (CH-344)

Sr. No.	Topic	No. of Lectures
1	Solvent Extraction	08
2	Chromatography	10
3	Gas Chromatography	09
4	High Performance Liquid Chromatography	09
5	Electrophoresis	06
6	Nephelometry and Turbidimetry	06
Total Lectures		**48**

1. Solvent Extraction (08L)

Introduction, Principle of solvent extraction, Distribution coefficient, distribution ratio, relationbetween Distribution coefficient and distribution ratio, factors affecting solvent extraction,percentage extracted, solvent extraction method, separation factor, batch extraction, counter currentextraction, application of solvent extraction, numerical problems.

References: 3,4,7,9 relevant pages**.**

Aims and Objectives

A student should know,

i) Principles of solvent extraction.

ii) Difference between KD and D

iii) Various types of techniques of solvent extraction such as-

(a) extraction (b) continuous extraction (c) counter current extraction.

iv) Difference between batch and multiple extraction.

v) Advantages and applications of solvent extraction.

vi) To solve the numerical problems.

2. Chromatography (10L)

Introduction and classification of chromatographic methods, Principle of chromatographic analysis with match box model, Theoretical plates and column efficiency, Theory, Principle, technique and applications of-Column Chromatography, Ion exchange Chromatography, Thin layer Chromatography, Paper Chromatography, Numerical Problems

Ref. 1-8 Relevant pages

Aims and Objectives

Student should know:

1. Principle of chromatographic methods
2. Relation between theoretical plates and column efficiency
3. Technique and applications of- Column Chromatography,
4. Technique and applications of- Thin layer Chromatography
5. Technique and applications of- Paper Chromatography

6. Technique and applications of- Ion exchange Chromatography
7. Numerical Problem

3. Gas Chromatography (09 L)

Introduction, Theory, Principle, GSC and GLC, Separation mechanism involved in GSC and GLC, Instrumentation of Gas chromatography, Working of gas chromatography,Gas chromatogram and qualitative-quantitative analysis, Applications of gas chromatography

Ref. 1. Pg. 167-174

Ref. 4. Pg. 454-464

Ref. 5 Pg. 624-640

Aims and Objectives
Student should know,
1 Principle of GSC and GLC analysis
2. Separation mechanism involved in GSC and GLC
3. Instrumentation- stationary phases, column types, detectors
4. Working of gas chromatographic apparatus.
4. Chromatogram and use in qualitative-quantitative analysis
5. Applications of gas chromatography

4. High Performance Liquid Chromatography (09 L)

Introduction, Need of liquid chromatography, Separation mechanism involved in adsorption and partition HPLC, Instrumentation and working of HPLC, Applications of HPLC, Introduction to supercritical fluid chromatography

Ref. 6. Pg. 529-545

Ref. 4. Pg. 178-183

Aims and Objectives
Student should know,
1 Need of liquid chromatography
2. Separation mechanism involved in adsorption and partition HPLC
3. Instrumentation and working of HPLC
4. Applications of HPLC
5. Advantages of supercritical fluid chromatography

5. Electrophoresis (06L)

Introduction, Principle and theory of electrophoresis, Different types of electrophoresis techniques, Moving Boundary Electrophoresis, Zone electrophoresis- Paper, Cellulose acetate and Gel electrophoresis, Applications of electrophoresis

Ref. 3 and Ref. 4 relevant pages

Aims and Objectives
Student should know,
1 Comparison between electrophoresis and chromatography

2. Principle and theory of electrophoresis
3. Different types of electrophoresis techniques
Applications of electrophoresis

6. Nephelometry and Turbidimetry (06L)

Introduction, Principles and instrumentation of Nephelometric and Turbidimetric analysis, Difference between Nephelometric and Turbidimetric measurements, Choice between Nephelometry and Turbidimetry, Factors affecting Nephelometric and Turbidimetric measurements, Quantitative Applications, Numerical Problems

Ref.1. Pg.781-785

Ref.3. Pg.380-390

Aims and Objectives
Student should know,
1. Nephelometry and Turbidimetry as an analytical tool
2. Measurement of turbidance
3. Difference between Nephelometry and Turbidimetry
4. Application and numerical problems

List of References

Ref.1 Textbook of Quantitative Chemical Analysis- 3rd Edition, A. I. Vogel

Ref.2 Principles of Physical Chemistry 4th edition – Prutton and Marron

Ref.3 Instrumental Methods of Chemical Analysis- Chatwal and Anand

Ref.4 Basic Concept of Analytical Chemistry-2nd edition S.M. Khopkar

Ref.5 Vogel's textbook of Quantitative Inorganic Analysis-4th edition
Besset Denney, Jaffrey, Mendham

Ref.6 Instrumental Methods of Chemical Analysis- 6th edition
Willard, Merritt, Dean and Settle

Ref.7 Analytical Chemistry by Skoog

Ref.8 Introduction to Instrumental Analysis- R.D. Braun

Ref.9 Instrumental methods of Chemical Analysis-Willard, Dean & Merrit-6th Edition

Semester- III

Course: Industrial Chemistry (CH-335)

Topics	No. of lectures
1. Modern Approach to Chemical Industry	08
2. Agrochemicals	08
3. Manufacture of Basic Chemicals	08
4. Petrochemicals and eco-friendly fuels	08
5. Food and Starch Industry	08
6. Cement and Glass industry	08
Total Lectures	**48**

1. Modern Approach to Chemical Industry (08)

Introduction, basic requirements of chemical industries, chemical production, raw materials, unit process and unit operations, Quality control, quality assurance, process control, research and development, pollution control, human resource, safety measures, classification of chemical reactions, batch and continuous process, Conversion, selectivity and yield, copy right act, patent act, trade marks

Ref. 1: Chapter 2 (relevant pages)

2. www.wikipedia.org/wiki/copyright_act_of1976

3. www.wikipedia.org/wiki/patentact

4. www.wikipedia.org/wiki/trademark

2. Agrochemicals (08)

General introduction and scope of agrochemicals, meaning and examples of: Insecticides, Herbicides, Fungicides, Rodenticides, Pesticides, Plant growth regulators. Pesticide formulation, slow release pesticide formulations, storage stability test, and Industrial entomology. Advantages and disadvantages of agrochemicals. Structure,: DDT, BHC, Warfarin, Aldrin, Endosulphan,synthesis and application:DDT, BHC andEndosulphan. Biopesticides like Neem oil and Karanj oil.

Ref. No. 5-7

3. Manufacture of Basic Chemicals (08)

a) Ammonia: Physicochemical principles involved, Manufacture of ammonia by modified Haber-Bosch process, its uses.

b) Sulphuric acid: Physicochemical principles involved, Manufacture of sulphuricacid by contact process, its uses.

c) Nitric acid: Physicochemical principles involved, Manufacture of nitric acid by Ostwald's process, its uses.

Ref.No.1: P.No. 571 to 588, 618 to 664

4. Petrochemicals and eco-friendly fuels (08)

a) Introduction, occurrence, composition of petroleum, resources, processing of petroleum, calorific value of fuel, cracking, octane rating (octane number), cetane number, flash

point, and petroleum refineries, applications of petrochemicals, synthetic petroleum, lubricating oils & additives

b) *Fuels and eco-friendly fuels:* liquid, gaseous fuel (LPG, CNG), fossil fuels, diesel, bio diesel, gasoline, aviation fuels. Use of solar energy for power generation.

Ref. 15, 16, 17

5. Food and Starch Industry (08)

Food Industry:

(a) Definition and scope, nutritive aspects of food constituents, , food deterioration factors and their control; (b) Preservation and processing: Heat and cold preservation and processing, cold storage, food dehydration and concentration, various foods, their processing and preservation methods, fruits, beverages, cereals, grains, legumes and oil seeds; (c) Food additives: Enhancers, sugar substitutes, sweeteners, food colors,

Ref.12

Starch industries:

Chemistry of starch, manufacturing of industrial starch and its applications, characteristics of some food starches, non-starch polysaccharides-cellulose-occurrence.

Ref. 11

6. Cement and Glass industry (08)

Cement industry:

Introduction, Importance, composition of portland cement, raw materials, proportioning of raw materials, setting and Hardening of cement, reinforced concrete.

Ref.1: P.No. 313-333 Ref. 8: P.No173-176, Ref. 10: P.No.188-192

Glass industry

Introduction, importance, physical and chemical properties of glass, chemical reaction, annealing of glass Special glasses: colored, safety, hard, borosilicate, optical, photosensitive, conducting, glass laminates.

Ref.1: *P. No*.160-171;Ref. 8: *P. No*. 247-265; Ref.9: *P. No*. 197-212

Aims and objectives

1. Modern Approach to Chemical Industry

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. Agrochemicals

Students should know the

i. Various insecticides,

ii. Pesticides,
iii. Fungicides,
iv. Rodenticides &biopesticides used in agriculture field with their synthesis and applications.

3. Manufacture of Basic Chemicals

Students should know the
i. Concept of basic chemicals,
ii. their uses and manufacturing process.
iii. They should also know the physic chemicals principals involved in manufacturing process

4. Petrochemicals and eco-friendly fuels

Introduction, occurrence, composition of petroleum, resources, processing of petroleum, other properties
Fuels and eco-friendly fuels, use of solar energy etc.

5. Food and Starch Industry

Food Industry:

Students should know
i. Scope,
ii. Nutritive aspects of food constituents,
iii. Quality factors and their measurements,
iv. Food deterioration factors and their control;
v. Food preservation and Food additives

Starch Industry:

Students should know about the
i. Chemistry of starch,
ii. Manufacturing of industrial starch and its applications,
iii. Characteristics of some food starches,
iv. Non-starch polysaccharides-cellulose-occurrence

6. Cement and Glass industry

Cement industry

The students are expected to
i. Learn importance of these industries,
ii. Manufacture of cement by modern methods
iii. Definition of setting and hardening
iv. Reinforced concrete

Glass industry

The students are expected
i. To learn about making of glass by different methods,
ii. Various operations involved in the manufacture and compositions,
iii. Properties and uses of special glasses.

References

1. Industrial Chemistry-B.K. Sharma, Goyal publishing house, Mirut, Chapter 2 (relevant pages)
2. www.wikipedia.org/wiki/copyright_act_of1976
3. www.wikipedia.org/wiki/patentact
4. www.wikipedia.org/wiki/trademark
5. Insects and Pesticides, Saxena A B, Anmol Publications
6. Emergency Medicine: Chapter 146 Insecticides, Herbicides & Rodenticides, by James Adams
7. Growth Regulators in Agriculture and Horticulture, by Amarjit Basra, CRC Press, 2000
8. Shreeve's chemical process industries 5th Edition, G.T. Oustin, McGraw Hill
9. Riegel`s hand book of Industrial chemistry, 9th Edition, Jems A. Kent
10. Industrial chemistry –R.K. Das, 2nd Edition, 1976.
11. Chemistry and industry of starch, New York, N.Y., Academic Press, incby Kerr, Ralph Waldo Emerson
12. The Complete Manual Of Small-Scale Food Processing, by Peter Fellows, Practical Action Pub
13. Polymeric Materials, C. C. Winding and G. D. Hiatt McGraw Hill Book Co. Polymer Science by Gowarikar
14. Polymer science, Bill Meyer, F. W. Jr. John Wiley& sons
15. The Petroleum chemicals industry by R. F. Goldstine, e &Fn London
16. Fundamentals of petroleum chemical technology by P Below.
17. Petro Chemicals Volume 1 and 2 ; A Chauvel and Lefevrev ; Gulf Publishing company
18. Perfumes Soaps Detergents & Cosmetics (Soaps & Detergents) (Volume 1) 1st Edition, CBS Publisher
19. Dyes & Paints: A Hands-On Guide to Coloring Fabric, by Elin Noble

Semester- IV
Course: Industrial Chemistry (CH-345)

Topics	No. of lectures
1. Polymer chemistry	10
2. Sugar and Fermentation Industry	08
3. Soap, detergents and Cosmetics	08
4. Dyes and paints	08
5. Chemistry of pharmaceutical industries	08
6. Pollution prevention and waste management	06
Total Lectures	**48**

1. Polymer chemistry (10)

Classification of Polymers: Organic and Inorganic polymers

(a) Basic concepts, nomenclature, degree of polymerization, classification of polymerization reactions, thermodynamic and transport properties of polymer

b)*Commercial polymers and their importance:* (a) Nylon, polyesters (terylene and dacron), rubber, vulcanization of rubber, synthetic rubber, Bun 2-N rubber, copolymers of butadiene, PVC, acrylic, teflon, polyethylene and acrylonitrile; (b) Silicone polymers: silicone oils, rubber, grease and resin; (c) Resins: Phenol-formaldehyde resins, urea-formaldehyde resins, epoxy resins, melamine-formaldehyde resins;

Ref. 13, 14

2. Sugar and Fermentation Industry (08)

Sugar: Occurrence, Manufacturing of refine cane sugar from sugar cane, general idea of carbonation and sulphitation processes and their comparison, by-product and their use.

Ref.8-10

Fermentation Industry:

Introduction, importance, Basic requirement of fermentation process, Manufacture of industrial alcohol from molasses, fruits, food grains, & ethylene, Manufacturing of wine, beer, whisky, rum ; importance Power alcohol

Ref. 1, 8-10

3. Soap, detergents and Cosmetics (08)

A. Chemistry of soap, row material, chemical reaction, types of soap.
B. Meaning of the terms detergent and surfactants, emulsion and emulsifying agents, wetting and non-wetting, hydrophobic and hydrophilic nature, amphipathic structures, types of surfactants, raw materials for detergents, washing action of soaps and detergents, detergent builders, additives.

C. Raw materials: emulsifiers (natural, synthetic and finely dispersed solids), lipid components (oils, waxes, fats), humectants, colours (dyes and pigments), preservatives and antioxidants. (b) Cosmetics for skin: Types and problems of skin, key ingredients of skin cleansing, toners, moisturizers, nourishing, protective sunscreen, talcum powder and bleaching products. (c) Hair care: classification, ingredients, special additives for conditioning and scalp health, hair colourants (temporary, semi-permanent and gradual colourants), the plant materials (herbs) used in hair cosmetics.

Ref. 18.

4. Dyes and paints

(a)*Dyes:* Introduction, classification of dyes: Structures and applications, nitro, nitroso, azo, heterocyclic, phthalenes, xanthenes, rhodamines, thiazine, cyanine, anthraquinone, indigoids, thioindigoids, phthalocyanines, wet dyes.

(b) *Paints:* Introduction of paints, ingredients and classification, new technologies; properties of coatings; solvents, plasticizers, dyes and bioactive additives;

(c) *Pigments:* Introduction, classification and general physical properties.

Ref.1: P. No.777-814; Ref.9: P. No.863-915 ;Ref.10 Relevant page
Ref. 19.

5. Chemistry of pharmaceutical industries (08)

a. *General aspects of drug action:* Introduction, classification, nomenclature, structure-activity relationship, action of drugs, factors affecting drug action, metabolism of drugs, chemical structures, methods of production and pharmacological activity.

b. Meaning of the terms: Prescriptions, doses, analgesic, antipyretic, diuretic, anesthetics, antibiotics, anti-inflammatory, anti-viral, tranquilizer, antiulcer, antialargic and bronchodilators, cardiovascular, cold preparations, anti-hypertensive, cough preparation, anti-neoplastic, sedative and hypnotics, steroidal, contraceptive, histamine and antihistamine.

c. Synthesis and uses: Paracetamol, Aspirin, Sulphanilamide.

Ref.1: P. No.762-775; Ref.8: P. No.803-804, 818-822 ; Ref.9: P. No.987-1011

6. Pollution prevention and waste management (06)

Introduction, importance of waste management, concept of atom economy, Terms involved in waste minimization: source reduction, recycling, product changes, source control, use and reuse, reclamation, assessment procedures, types of wastes, treatment and disposal of industrial waste. Treatment of wastes or effluents with organic impurities.Treatment of wastes or effluents with inorganic impurities. The nature, effect and treatment of some important chemical wastes-(Pulp and paper industries, soap and detergent industries and food processing
industries).

Ref. 1: P.No. 8-92; Ref.6: P.No. 15-30;
Ref. www.wikipedia.org/atom economy

Aims and Objectives:

1. Polymer chemistry

Students should know

i. Basics of polymer,
ii. ii. Nomenclature,
iii. Degree of polymerization,
iv. Classification of polymerization reactions,
v. Thermodynamic and transport properties of polymer,
vi. Commercial polymers and their importance,
vii. Biomedical polymers: implants,
viii. Contact lens and dental polymers.

2. Sugar and Fermentation Industry

The students are expected to learn

i. Importance of sugar industry,
ii. Manufacture of direct
iii. Consumption (plantation white) sugar with flow diagram.
iv. Cane juice extraction by various methods,
v. Clarification by processes like carbonation,
vi. Sulphitation,
vii. Phosphatation, etc.
viii. Concentration of juice by using multiple effect evaporator system,
ix. Crystallization of sucrose by using vacuum pan.

Fermentation Industry

i. Importance,
ii. Basic requirement of fermentation process,
iii. Manufacturing of ethyl alcohol by using molasses,
iv. Food grains, fruits & ethylene.
v. Manufacturing of wine, beer, whisky, rum etc.

3. Soap, detergents and Cosmetics

Students should know about

i. Different types of soap products,
ii. Chemistry of soap.
iii. Students should know about various cosmetics,
iv. Raw materials,
v. Properties and various types of cosmetics used.
i. Meaning of the terms detergent,
ii. Surfactants, emulsion and emulsifying agents,
iii. Wetting and non-wetting,
iv. Hydrophobic and hydrophilic nature,
v. Amphipathic structures,
vi. Types of surfactants,
vii. Raw materials for detergents,

viii. Washing action and detergents,
ix. Detergent builders, additives.

4. Dyes and paints

Students should know about

i. *Dyes:* introduction,
ii. Dye intermediates,
iii. Preparation of dye intermediates,
iv. Structural features of a dye;
v. Classification of dyes,
vi. Structures and applications,
vii. Nitro, nitroso,
viii. Azo, heterocyclic,
ix. Phthalenes,
x. Xanthenes,
xi. Rhodamines,
xii. Thiazine,
xiii. Cyanine,
xiv. Anthraquinone,
xv. Indigoids,
xvi. Thioindigoids,
xvii. Phthalocyanines, wet dyes.

(b) *Paints:*

i. Introduction of paints,
ii. Ingredients and classification,
iii. New technologies;
iv. Properties of coatings;
v. Solvents, plasticizers, dyes and bioactive additives.

(b) *Pigments:*

i. Introduction,
ii. Classification and general physical properties.

5. Chemistry of pharmaceutical industries

Students should know about

i. *General aspects of drug action:*
ii. Introduction, classification,
iii. Nomenclature,
iv. Structure-activity relationship,
v. Action of drugs,
vi. Assay of drugs and factors affecting drug action,
vii. Metabolism of drugs,
viii. Chemical structures,
ix. Methods of production and pharmacological activity.
x. Meaning of the terms of the various drugs.
xi. Synthesis and uses of few drug molecules.

6. Pollution prevention and waste management

The students are expected to learn all the problems of pollution and deposal of waste of various industries.

References

1. Industrial Chemistry-B.K. Sharma, Goyal publishing house, Mirut, Chapter 2 (relevant pages)
2. www.wikipedia.org/wiki/copyright_act_of1976
3. www.wikipedia.org/wiki/patentact
4. www.wikipedia.org/wiki/trademark
5. Insects and Pesticides, Saxena A B, Anmol Publications
6. Emergency Medicine: Chapter 146 Insecticides, Herbicides & Rodenticides, by James Adams
7. Growth Regulators in Agriculture and Horticulture, by Amarjit Basra, CRC Press, 2000
8. Shreeve's chemical process industries 5th Edition, G.T. Oustin, McGraw Hill
9. Riegel`s hand book of Industrial chemistry, 9th Edition, James A. Kent
10. Industrial chemistry –R.K. Das, 2nd Edition, 1976.
11. Chemistry and industry of starch, New York, N.Y., Academic Press, incby Kerr, Ralph Waldo Emerson
12. The Complete Manual Of Small-Scale Food Processing, by Peter Fellows, Practical Action Pub
13. Polymeric Materials, C. C. Winding and G. D. Hiatt McGraw Hill Book Co. Polymer Science by Gowarikar
14. Polymer science, Bill Meyer, F. W. Jr. John Wiley& sons
15. The Petroleum chemicals industry by R. F. Goldstine, e &fn London
16. Fundamentals of petroleum chemical technology by P Below.
17. Petro Chemicals Volume 1 and 2 ; A Chauvel and Lefevrev ; Gulf Publishing company
18. Perfumes Soaps Detergents & Cosmetics (Soaps & Detergents) (Volume 1) 1st Edition, CBS Publisher
19. Dyes & Paints: A Hands-On Guide to Coloring Fabric, by Elin Noble

Optional Course

Semester-III

Course: Nuclear Chemistry (CH-336A)

Topic	No. of Lectures
1. The Atomic Nucleus, Properties of Nucleons and Nuclei	08
2. Nuclear Models	12
3. Radioactivity	16
4. Nuclear Reactions	12
Total Lectures	**48**

1. The Atomic Nucleus, Properties of Nucleons and Nuclei (08 L)

The atom, Elementary particles, Sub-nucleons, quarks, The nucleus and outer sphere, Classification of nuclides, Nuclear stability, Even-odd nature, N/Z ratio, The Nuclear potential, Binding energy, Binding energy calculations.
The nucleus, its size, shape and radius, Mechanical effects due to orbiting and spinning of nucleons, Magnetic quantum numbers, principal and radial quantum number.

Ref.1: pages 1 to 13 and19 to 25.

2. Nuclear Models (12 L)

Historical, The shell model, Periodicity in nuclear properties: the magic numbers, The salient features of shell model, The sequence of filling the orbit, Rectangular well potential model, Harmonic oscillator potential model, Spin-orbit coupling model, Nuclear configuration of lighter nuclides ($Z < 20$), Merits of the shell model, The liquid drop model, The semi-empirical mass equation, Merits of the liquid drop model, Limitations of liquid drop model.

Ref.1 pages 64 to 69, 72 to 84 and 91 to 92.

Ref.2 pages 464 to 469

3. Radioactivity (16 L)

Discovery, Types of radioactive decay, Decay schemes,General characteristics of radioactive decays, decay kinetics, units of radioactivity, problem solving on decay kinetics.

Alpha decay: Alpha active nuclides, The alpha energy spectrum,Geiger-Nuttals law, The theory of alpha decay. **Beta decay:** Types of beta decay, absorption and range through matter, Fermi theory of beta decay. (Mathematical details are not expected) **Gamma decay:** Nuclear isomerism and isomeric transitions, internal conversion, Auger effect.

Ref.1 pages 100 to 106,120 to 135, 138 to 142, and 150 to 154.

4. Nuclear Reactions (12 L)

Bethe's notation, Types of nuclear reactions, Conservation of nuclear reactions (Conservation of protons and neutrons, Conservation of momentum and energy), Reaction cross-section, The compound nucleus theory, Calculations of excitation energy of compound nucleus, Photonuclear reactions, Thermonuclear reactions.

Ref.1 pages 160 to 174 and 192 to 196.

Aims and objectives:

1. The Atomic Nucleus, Properties of Nucleons and Nuclei:

The students are expected to know the following from this topic.

a) The atom, elementary particles,sub-nucleons and the quarks.

b) Classification of nuclides, isotopes, isobars, isotones and isomers.

c) Nuclear stability on the basis of even-odd nature of Z and N, N/Z ratio. d) The binding energy

e) The nucleus, its size and shape, mechanical effects due to orbiting and spinning ofnucleons, Magnetic quantum numbers, principal and radial quantum number.

2. Nuclear Models:

By studying this topic students are expected to understand

a) The Shell model
b) Magic number
c) Salient features of shell model
d) Nuclear configuration
e) The liquid drop model
f) Semi-empirical mass equation

3. Radioactivity:

By studying this topic students are expected to understand

a) Types of radioactive decay, decay kinetics and their general characteristics.

b) Alpha decay, Beta decay and gamma decay

c) Nuclear isomerism, isomeric transitions, internal conversion, Auger effect.

4. Nuclear Reactions:

The students are expected to understand,

a) Bethe's notation

b) Different types of Nuclear reactions.

c) Conservation in nuclear reaction

d) Excitation energy of compound nucleus

References:

1. Essentials of Nuclear Chemistry by H. J. Arnikar, 4th Revised Edition, New Age International Publishers.

2. Source book of Atomic energy by Samuel Glasstone, 3rd edition, East -West press.

Semester-IV

Course: Nuclear Chemistry (CH-346A)

Topic	No. of Lectures
1. Nuclear Fission	10
2. Nuclear Reactors	08
3. Nuclear Accelerators	08
4. Detection and measurement of nuclear radiations	08
5. Applications of Radioactivity	10
6. Radiation Safety precautions	04
Total Lectures	**48**

1. Nuclear Fission (10 L)

Introduction, Discovery of nuclear fission, The process of nuclear fission, Fission fragments and their mass distribution, Fission energy, Fission cross-section and thresholds, Fission neutrons, Theory of nuclear fission**.**

Ref.1: pages 209 to 225

2. Nuclear Reactors (08 L)

The fission energy, The natural uranium reactor, The four factor formula, The classification of reactors. Reactor power, Critical size of a thermal reactor, Breeder reactor, The fast breeder test reactor at Kalpakkam, India's nuclear energy programme.

Ref.1: pages 232 to 249

3. Nuclear Accelerators (08 L)

Electrostatic Accelerators, The cockcroft-walton Accelerator,The Vande-Graft Accelerator, Cyclic Accelerator, Linear Accelerator**.**

Ref: 2 Pages 290 to 305,325 to 330

4. Detection and measurement of nuclear radiations (08 L)

Scintillation Counters, Semiconductor detectors, Neutron detectors.

Ref.2 Pages 211 to 222.

5. Applications of Radioactivity (10 L)

Probing by isotopes, Typical reactions involved in the preparation of radioisotopes, Szilard-Chalmer reaction, Cow and milk system, Use of charged plates in the collection of radioisotopes, Radiochemical principles in the use of tracers, Analytical applications: Isotope dilution analysis, Neutron activation analysis, Radiometric titrations, Numericals, medical applications a) thyroidisis (goitre), b) radioimmunoassay.

Ref.1 Pages 309 to 328, 338 to 345

6. Radiation Safety precautions (04 L)

Safety standards, safe working methods, biological effects of radiations, nuclear waste and its management.

Ref.3 Pages 322 to 328

Aims and objectives:

1. Nuclear Fission:

By studying this topic students are expected to understand

a) Discovery of nuclear fission

b) The process of nuclear fission

c) The charge distribution

d) Fission energy

e) Theory of nuclear fission

2. Nuclear Reactors

The students are expected to know the following from this topic

a) the natural Uranium reactor, The breeder reactor

b) the four factor formula

c) Classification of reactors. d) India's Nuclear Energy programme

3. Nuclear Accelerators:

The student should understand

a) Principle and working of various accelerators

b) What are the electrostatic accelerators?

4. Detection and measurement of nuclear radiations

The aims and objectives are as follows

a) Gaseous ionization and its applications

b) Principle and working of Scintillation Counters , Semiconductor detectors, Neutrondetectors

5. Applications of Radioactivity

The students are expected to know the following from this topic

a) The Probing by isotopes.

b) Typical reactions involved in the preparation of radioisotopes

c) Szilard-Chalmer reaction

d) Analytical applications – Isotope Dilution Analysis, Neutron Activation Analysis, Radiometric Titrations

e) Medical applications such as thyrodisis and radioimmunoassay.

6. Radiation Safety precautions

By studying this topic students are expected to understand

a) Biological effects of radiations, safety standards, safe working methods
b) Reprocessing of the nuclear waste and its management.

References :

1. Essentials of Nuclear Chemistry by H. J. Arnikar, 4th Revised Edition, New Age International Publishers

2. Source book of Atomic energy by Samuel Glasstone, 3rd edition, East -West press.

3. Nuclear Physics by Irving Kaplan, 2nd edition.

4. Introduction to Nuclear physics and chemistry by B.G. Harvey.

5. Fundamentals of Radiochemistry by D. D. Sud, A.V. R. Reddy and N. Ramamoorthy.

Semester- III

Course: Polymer Chemistry (CH-336B)

Topic	No. of lectures
1. Introduction to Polymer Chemistry	04
2. Mechanism and Nomenclature of Polymers	04
3. Chemistry of Polymerization	10
4. Polymerization Techniques	08
5. Polymer Additives	06
6. Molecular Weights of Polymers	05
7.Silicone and Cellulose Polymers	04
8. Polymer Reactions	07
Total Lectures	**48**

1. Introduction to Polymer Chemistry (04 L)

Brief History, Polymer definition, Preparation, Classification, Structures, Chemical bonding & Molecular forces in Polymers.

Ref. 1: Pages 1-14

Ref. 2: Pages 1-16

Ref. 3: Pages 1-12

Ref. 4: Pages 1-17

Ref. 7: Relevant Pages

Ref. 9: Pages 1-8

2. Mechanism and Nomenclature of Polymers (04 L)

a) Polymerization Mechanism, b) Nomenclature of Polymers-i) Common/Trivial names ii) Source-Based names, iii) Structure-Based names (Non IUPAC), iv) IUPAC Structure-based and Linkage-based nomenclature system and v) Trade names / Brand names & Abbreviations

Ref. 4: Pages 11-25 **Ref. 12: Pages 6-17**

3. Chemistry of Polymerization (10 L)

a) Introduction, b) Chain Polymerization: Free radical Polymerization, Ionic polymerization, Co-ordination polymerization- Ziegler-Natta catalyst c) Step Polymerization: Polycondensation, Polyaddition polymerization, and Ring Opening polymerization.

Ref. 1: Pages 15-64

Ref. 2: Pages 25-32, 49-56, 82-86, 88-89, 91-94

Ref. 3: Relevant Pages

Ref. 4: Relevant Pages

Ref. 6: Relevant Pages

Ref. 9: Pages 22-63

4. Polymerisation Techniques (08 L)

Bulk polymerisation, Solution polymerization, Suspension polymerization, Emulsion polymerization, Melt polycondensation, Solution Polycondensation, Interfacial condensation, electrochemical polymerisation, Salient features of different polymerization techniques

Ref. 1: Pages 71-79, 82-84

Ref. 2: Pages 126-132

Ref. 4: Pages 309-324

Ref. 12: Pages 335-341, 173-175

5. Polymer Additives (06 L)

Fillers & Reinforcement, Plasticizers, Antioxidants & Thermal Stabilizers (Heat Stabilizers), Ultraviolet stabilizers, Fire retardants, Colourants, Antistatic agents & Curing agents.

Ref. 3: Pages 170-176

Ref. 4: Pages 502-512, 528-538

Ref. 10: Relevant Pages

6. Molecular Weights of Polymers (05 L)

a) 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

Ref. 2&4: Relevant Pages

7. Silicone and Cellulose Polymers (04 L)

a) Introduction, Synthesis, Reactions, Uses of Silicone polymers, b) Cellulose & Derivatives of cellulose: Rayon, Cellophane, Cellulose nitrate, Cellulose acetate and their uses.

Ref. 1: Pages 255-261

Ref. 5: Pages 143-155

8. Polymer Reactions (07 L)

Introduction, Hydrolysis, Hydrogenation, Addition and Substitution reactions, Cross-linking reactions, Cure reactions, Reactions of various aliphatic and aromatic pendent groups in polymers.

Ref. 1: Pages 291-297, 306-308, 311-321, Ref. 3: Relevant Pages, Ref. 4: 545-555

Aims and Objectives:

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 methods 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) Importance of silicone polymers.
10) Derivatives of cellulose polymers & their applications.
11) Ingredients added to polymers.
12) What are fillers.
13) Polymer reactions and applications.
14) Polymer reactions and their effect on physical and chemical properties.
15) Advantages of polymer reactions to change their properties.

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, 3rdEdn. A Wiely-Interscience Publication John Wiely& 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.), 6thEdn, (First Indian Print 2005), New York-Basel.

5. Inorganic Polymers by G.R.Chatwal Himalaya Publishing House 1st Edn.1996

6. Polymer Science – A Text Book by V.K. Ahluwalia, Anuradha Mishra.

7. Principle of Polymer Science by P. Bahadur, N.V. Sastry, 2ndEdn, Narosa Publishing House.

8. Polymer Chemistry by Ayodhya Singh, 2008, Published by Campus Book International, New Delhi.

9. Organic Polymer Chemistry by Jagdamba Singh, R.C. Dubey, 4thEdn, 2012.

10. Advanced Polymer Chemistry by V.K. Selvaraj, 1stEdn, 2008, Published by Campus International, New Delhi.

11. Organic Polymer Chemistry by V. Jain, IVY Publishing House, New Delhi.

12. Principles of Polymerisation by George Odian3rdEdn. John Wiely& Sons New York.

Semester- IV

Course: Polymer Chemistry (CH-346B)

Topic	No. of lectures
1. Polymer Degradation	03
2. Chemical and Geometrical structures of Polymer Molecules	04
3. Glass Transition Temperature and Heat Distortion Temperature (Softening Point)	05
4. Crystallinity in polymers	04
5. Some Important Polymers	08
6. Analysis and testing of polymers	06
7. Some Special Polymers	06
8. Polymer Processing	12
Total Lectures	**48**

1. Polymer Degradation (03 L)

Introduction, Types of Degradation, Thermal degradation, Mechanical degradation, Photo degradation.

Ref. 1: Pages 262 – 277 Ref. 3: Pages 151-160

Ref. 4: Relevant Pages Ref. 11: Pages 60-65

2. Chemical and Geometrical structures of Polymer Molecules (04 L)

a) Microstructures based on chemical structures-Organic & Inorganic polymers, Homochain&Heterochain polymers, Homopolymers& Copolymers, b) Microstructures based on geometrical structures-Interpenetrating coils, Folded chain, Helical chain, Linear, Branched, Random, Alternating, Graft and Block polymers and c) Stereo-regular polymers-Optical and Geometric Isomerism.

Ref 1: Pages 136-149 Ref 4: Relevant Pages

3. Glass Transition Temperature (GTT) and Heat Distortion Temperature(Softening Point)**(05 L)**

Definition, Factors influencing the Glass transition temperature, Glass transition temperature and molecular weight, Glass transition temperature and plasticizers, Glass Transition Temperature and Crystalline melting point (Tm), Importance of Glass transition temperature.

Ref 1: Pages 150, 163-169, 171-172, 219 Ref 4: Relevant pages

Ref 9: Page 113-116 Ref 10: Pages 47-58

4. Crystallinity in polymers (04 L)

Introduction, Degree of Crystallinity, Crystallisability, crystallites, Factors affecting crystallisability, Effect of crystallinity on the properties of polymers.

Ref. 1: Pages 173-177, 180-183, 189-191, Ref. 5: Pages 69-74, Ref. 9: Pages 103-112

5. Some Important Polymers (08 L)

Polystyrene, Polymethylmethacrylate, Polyester, Polycarbonates, Polyamides, Polyvinyl alcohol (PVA), Polyvinyl chloride (PVC), Polytetrafluoroethylene (Teflon) &polyvinyl fluoride, lyisoprene, Polyimide, Phenol formaldehyde resin (Novolac), Urea formaldehyde resin, Epoxy polymers.

Ref. 1: Pages 213-254, **Ref. 3: Relevant Pages**

Ref. 4: Relevant Pages, **Ref. 8: Relevant Pages**

6. Analysis and testing of polymers **(06 L)**

a) Spectroscopic Methods: IR, NMR, b) Thermal analysis: Differential Scanning Calorimeter (DSC), &Thermo Gravimetric Analysis (TGA), c) Physical testing: Mechanical properties, Thermal properties, Optical properties, Electrical properties, Chemical properties.

Ref 2: Pages 229-237, 242-252, **Ref 4: Pages 121-139**

7. Some Special Polymers **(06 L)**

Polymer blends, Bio-medical polymers, Biodegradable polymers, Liquid Crystalline polymers (LC's), Conducting polymers, thermally stable polymers, Optical fibers,

Ref. 4: Relevant Pages, **Ref. 6: Pages 179,185,197**

Ref.7: Pages 262-299, **Ref. 9: Pages 130-162**

8. Polymer Processing **(12 L)**

a) Plastic Technology **(04)**

1) Molding 2) Extrusion 3) Other processing methods: Calendaring, Film Casting, Coating, Foaming, Forming, Laminating & Low pressure molding, Compounding.

Ref. 2: Pages 457-469, 474-475., **Ref. 1, 4, 6, 7, 9: Relevant pages**

b) Fiber Technology **(04)**

1) Introduction, Textile & Fabric properties, 2) Fiber Spinning: i) Melt spinning ii) Dry spinning iii) Wet spinning and 3) Fiber after treatments: Scouring, Lubrications, Sizing, Dyeing, Finishing, Texture yarns, Nonwoven fabrics.

Ref 2: Pages 486-501, **Ref. 1, 4, 6, 7, 9: Relevant pages**

c) Elastomer Technology **(04)**

1) Introduction, Vulcanization (Sulphur& non sulphur vulcanization), 2) Reinforcement, Elastomer Compounding.

Ref. 2: Pages 506-518 , **Ref. 1, 4, 6, 7, 9: Relevant pages**

Aims and Objectives

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

1) What is polymer degradation?
2) Chemical and geometric structures of polymers.
3) Important polymers like PVC, polystyrene, polyvinyl alcohol, Teflon, Resins, nylon, epoxy polymers, etc.

4) Uses & properties of polymers.
5) Role of polymer industry in the economy.
6) Advantages of polymers.
7) Some industrially important polymers
8) What is polymer processing?
9) Different polymer processing techniques.
10) Polymer testing and analysis.
11) Properties of polymers & testing.
12) Various fiber spinning techniques.
13) Reinforcement & compounding 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 Wiely& 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. Inorganic Polymers by G.R.Chatwal Himalaya Publishing House 1st Edn.1996
6. Polymer Science – A Text Book by V.K. Ahluwalia, Anuradha Mishra.
7. Principle of Polymer Science by P. Bahadur, N.V. Sastry, 2nd Edn, Narosa Publishing House.
8. Polymer Chemistry by Ayodhya Singh, 2008, Published by Campus Book International, New Delhi.
9. Organic Polymer Chemistry by Jagdamba Singh, R.C. Dubey, 4th Edn, 2012.
10. Advanced Polymer Chemistry by V.K. Selvaraj, 1st Edn, 2008, Published by Campus International, New Delhi.
11. Organic Polymer Chemistry by V. Jain, IVY Publishing House, New Delhi.
12. Principles of Polymerisation by George Odian3rd Edn. John Wiely& Sons New YorkYork.

Semester- III

Course: Introduction To Biochemistry And Molecular Biology (CH-336C)

Name of the Topic	Number of lectures
1. Amino acids and Proteins	11
2. Carbohydrates	06
3. Lipids	06
4. Hormones	03
5. Enzymes	07
6. Vitamins and Coenzymes	04
7. Cell Biochemistry	05
8. Biochemical techniques	06
Total lectures	**48**

1. Amino acids and proteins: (11 L)

Introduction, biological functions, classification-based on structure, function and composition. Structural organization of proteins- primary, secondary, tertiary and quarternary structures (general overview). Factors that stabilize protein structure.Denaturation of Proteins.

Reference: 3, Chapter 4, Amino acids and Proteins, pg 45-71.

1)Foldings and misfoldings of protiens by stepwise process
2) Diseases caused by misfoldings of protiens for ex..Alzhimer,Prions
Reference: 1, Page no 116 to 153

2. Carbohydrates: (06 L)

Introduction of carbohydrates, Introduction and biological significance of proteoglycans, Glycoproteins, Glycolipids, Lectin Carbohydrates- Interaction(Sugar code). Analysis of carbohydrates.

Reference.1: page no. 255 to 268
Reference.2: Page no : 648 to 653 .

3. Lipids: (06 L)

Introduction, Biological significance, Classification-Simple ,compound, steroids and derived lipids. Structure of saturated and unsaturated fatty acids, structure of phospholipids (Phosphatidic acid, Lecithin, Cephalin, Lipositol), structure of Sphingomyelin and Cholesterol.Amphipathic lipids and their behavior in water.Saponification number, Acid number, Iodine number and their significance.Rancidity of lipids. Types of Lipoproteins and their significance, Structural Lipids in membrane glycerophopholipids, Sulphalipids, Galactolipids, glycosphingolipids

Reference.1: page no. 343 to 360
Reference: 3, Chapter 3, Lipids, pg 29-42.

4. Hormones: (03 L)

Definition, classification based on biochemical nature, location and mechanism of action. Concept of second messengers-c.AMP and Calcium inositide system.

Reference: 2, Chapter 42 and 43, pg 434, 462 and 464.

5. Enzymes: (07 L)

Classification- Six major classes of enzymes, Conjugated enzymes- Apoenzyme, Holo enzyme, prosthetic group (coenzymes and cofactors). Features of active site.enzyme specificity, Factors affecting enzyme activity- substrate concentration, pH, temperature, and enzyme concentration, product concentration. MM equation, LB equation (derivation not required) and significance of Km. Enzyme inhibition-competitive, non competitive and uncompetitive with suitable examples.Allosteric enzymes and clinical significance of Isoenzymes.

Reference: 3, Chapter 6, Enzymes, pg 85 – 112.

6. Vitamins and Coenzymes: (04 L)

Classification- Fat soluble and water soluble vitamins (source, biological functions and deficiency disorders), coenzyme forms of vitamin B complex.(Structure not required).

Reference: 2, Chapter 45: pg 481-496

7. Cell Biochemistry: (05 L)

Introduction to Cell, Unicellular and Multicellular organisms, Distinguishing features of Prokaryotic and Eukaryotic cell. Structure and function of Cell membrane, Mitochondria, Endoplasmic reticulum, Golgi complex, Lysosomes, Peroxisomes, Plant cell wall and Chloroplast. Concepts of Biomolecules and types of bonds in biomolecules.

Reference: 5, Chapter 3, Unicellular and multicellular cell, cell membrane, pg 32- 68, Chapter 10, Mitochondria, pg 191- 219, Chapter 6, Endoplasmic Reticulum, pg 154- 165, Chapter 7, Golgi Complex, pg 166- 174, Chapter 8, Lysosomes, pg 175- 183, Chapter 9, Peroxisomes, pg 184-189, Chapter 1, Chloroplast, pg 220- 240.

8. Biochemical techniques. (06 L)

Principle, working and applications of dialysis, Paper chromatography, Thin layer chromatography, Column chromatography- Gel filtration, Ion exchange, Affinity Chromatography. Electrophoresis- Paper and Gel (Agarose, Native and SDS- PAGE).

Reference: 6, Chapter 11, pg 524- 546. Chapter 10, pg 449- 473.**2**, Chapter 3, pg 89. 7, pg 344-421,

Aim and Objectives :

I **Cell Biochemistry**: The student needs to understand of Cell types, Difference between a bacterial cell., Plant cell and animal cell. Biological composition and organisation of cell membrane as per Singer and Nicholson model, structure and function of various cell organelles of plant and animal cell. Concepts of biomolecules,Bonds that link monomeric units to form macromolecules.

II.**Carbohydrates,:** The student needs to know 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.

III**. Lipids:** The student needs to know the types of lipids with examples, structure of lipids, properties of lipids.

IV. **Aminoacids and proteins:** The student needs to know the structure and types of amino acids. Reactions of amino acids.Properties of aminoacids.Peptide bond formation.Types of proteins.Structural hierarchy in proteins. Features of denaturation of proteins.

V. **Enzymes:** The student needs to 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.

VI. **Biochemical techniques:** The student needs to know the principle, working procedure and applications of various techniques used in biochemical studies.

VII.**Vitamins and Coenzymes:** The student needs to know the types of vitamins ,their source, biochemical significance and deficiency disorders. Coenzyme forms of Vitamin B complex and their metabolic significance.

VIII. **Hormones**: Basic concepts of Endocrinology.Types of Endocrine glands and their hormones.Biochemical nature of hormones.Role of Second messengers in hormone action.

Reference Books

1. Lehninger's, Principles of Biochemistry, by Nelson and Cox Macmillan Publisher 4thEdn..
2. Harper's Illustrated Biochemistry, 26th Edition.
3. Biochemistry by U. Satyanarayana
4. Biotechnology, B.D.Singh, 3rd edition.
5. Cell biology, Genetics, Molecular Biology, Evolution and Ecology, by Verma and Agarwal, 14th edition.
6. Principle techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, 6th edition.
7. Biophysical techniques by Upadhyay and Nath, 3rd revised edition.

Semester- III

Course: Introduction To Biochemistry And Molecular Biology (CH-346C)

Name of the Topic	Number of lectures
1. Introduction to Metabolism	02
2. Carbohydrate metabolism	06
3. Lipid metabolism	04
4. Amino acid metabolism	04
5. Electron Transport Chain and Oxidative Phosphorylation	06
6. Nucleic acids	07
7. DNA replication	06
8. Transcription	05
9. Translation	04
10. Introduction to Genetic engineering	04
Total lectures	**48**

1. Introduction to Metabolism: (02 L)

Definition of catabolism and anabolism, Types of metabolic reactions, High energy compounds, Significance of ATP.

Reference: 3, Chapter 12,Introduction to metabolism , pg 247- 249 and Chapter 11 Biological oxidation pg. 227-230.

2. Carbohydrate metabolism and TCA cycle (06 L)

Aerobic and anaerobic glycolysis- structures of intermediates, various enzymes involved and energetics. Fate of Pyruvate, Pyruvate dehydrogenase complex.TCA cycle- enzymatic reactions and energetics.

Reference: 2, Chapter 17: Glycolysis pp 136-144 and Chapter 16: The Citric Acid Cycle pp. 130-135

3. Lipid metabolism (04 L)

Transportation of fatty acids with the help of carnitine, β-oxidation of palmitic acid in mitochondria and its energetics.Triacylglycerol synthesis, ketogenesis.

Reference:2, Chapter 22, Oxidation of fatty acids: Ketogenesis, pp 180-189.

4. Amino acid metabolism: (04 L)

Significance of transamination, deamination, decarboxylation reactions of amino acids.Urea cycle.

Reference: 2, Chapter 29: Catabolism of Proteins and of amino acid nitrogen. pp 242 - 248

5. Electron Transport Chain and Oxidative Phosphorylation: (06 L)

Location of Electron carriers, Electron transport chain, Proton gradient, Oxidative phosphorylation-Chemiosmotic hypothesis, Inhibitors and Uncouplers of Electron transport chain and Oxidative phosphorylation .

Reference: 3, Chapter 11 Biological oxidation, pg 230-239.

6. Nucleic acids: (07 L)

Structures of Purines and Pyrinmidines, Nucleosides, Nucleotides, Polynucleotides.Difference between DNA and RNA. Watson and Crick model of DNA. DNA as genetic material (Macleod and Mcarty, Hershey and Chase experiments).RNA and its types.Central dogma of molecular biology.

Reference: 3, Chapter 5, Nucleic acids, pg 73-83.

7. DNA replication: (06 L)

Semiconservative model of replication (Messelson and Stahl experiment). Brief account of initiation (features of OriC), elongation and termination of DNA replication in prokaryotes. Okazaki fragments, Leading and Lagging strands, Distinguishing features of DNA polymerase I, II and III. Klenow fragment of DNA polymerase I.

Reference: 1, Chapter 25, DNA metabolism, pg 950 - 984

8. Transcription: (04 L)

Brief account of initiation- Promoter sequences, elongation and termination of transcription in prokaryotes. RNA polymerase. Examples of inhibitors of transcription. Chapter 26: 996- 1027

Reference: 1, Chapter 26, RNA metabolism, pg 948 – 1033.

9. Translation: (05 L)

Genetic code and its features.Brief account of initiation, elongation and termination of translation in prokaryotes.Examples of inhibitors of translation.Regulation of gene expression- Lac operon.

Reference: 1, Chapter 27, Protein metabolism, pg 1034- 1075.

10. Introduction to genetic engineering: (04 L)

Basic concepts of genetic engineering - Restriction Enzymes- Types and features, Vectors (Plasmids,Phages and Cosmids) , Recombinant or Chimeric vector. Principle and Steps involved in gene cloning with insulin as example. Applications of genetic engineering in various fields.

Reference: 1, Chapter 9, pg 307- 310, pg 311-313(vectors), **4**, Chapter 2, pg 15.

Aim and Objectives

a. Metabolism, Carbohydrate, Lipid and Amino acid metabolism: The student needs to know the significance of metabolism and energetics. Role of ATP and types of other high energy compounds.Individual reactions of the metabolic pathways, various enzymes and coenzymes, energetic and features of the pathway.

b. **Electron Transport Chain and Oxidative Phosphorylation**: The student needs to know the concepts of biological oxidation. Types of electron carriers and their location in mitochondria.Formation of proton gradient, Proton motive force and Oxidative phosporylation, formation of ATP in the oxysomes. Inhibitors and Uncouplersof Mitochondrial ETC.

c. **Nucleic acids:** Understanding the structures of purines, pyrimidines, nucleosides and nucleotides , structural features of nucleic acid types and their role. Central dogma of molecular biology. Experimental procedures that prove DNA as genetic material and its interpretations.

d. **Replication:** The student needs to know the experiment that showed the salient features of semi conservative DNA replication, stepwise events involved in replication of DNA.

e. **Transcription:** The student needs to know stepwise events of transcription of RNA and list of inhibitors of transcription.

f. **Translation**: The student needs to know the stepwise events of translation of proteins and its significance. List of inhibitors of translation.Features of regulation of gene expression with lac operon studies.

e. **Introduction to genetic engineering:** The student needs to know the overview of the steps involved in insulin gene cloning, and applications of genetic engineering in various fields like agriculture, industries and medicine.

Reference Books

1. Lehninger's, Principles of Biochemistry, by Nelson and Cox Macmillan Publisher 4thEdn..
2. Harper's Illustrated Biochemistry, 26th Edition.
3. Biochemistry by U. Satyanarayana
4. Biotechnology, B.D.Singh, 3rd edition.
5. Cell biology, Genetics, Molecular Biology, Evolution and Ecology, by Verma and Agarwal, 14th edition.
6. Principle techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, 6th edition.
7. Biophysical techniques by Upadhyay and Nath, 3rd revised edition.

Semester-III

Course: Environmental and Green Chemistry (CH-336D)

Name of the Topic	Number of lectures
1. Concepts and scope of Environmental Chemistry	02
2. Atmosphere and Air Pollution	14
3. Hydrosphere and water pollution	08
4. Introduction to Green Chemistry	10
5. Green Chemistry and Technology for sustainable development	10
6. Green Chemistry and Hazardous Organic Solvents	04
Total lectures	**48**

Chapter 1: Concepts and scope of Environmental Chemistry (02)

1.1 Introduction
1.2 Terminologies
1.3 Units of concentration
1.4 Segments of Environment
Ref. 1, Ref. 3

Aims and Objectives-
Students should know-
i. Importance and conservation of environment.

Chapter 2: Atmosphere and Air Pollution (14)

2.1 Composition and structure of atmosphere
2.2 Chemical and photochemical reactions in atmosphere
2.3 Chemistry of O_3, SOx, NOx and chlorides in atmosphere
2.4 Primary air pollutants
2.5 Sampling of air
2.6 Particulate matter: inorganic and organic
2.7 Smog: reducing and photochemical
2.8 Mechanism of ozone depletion
2.9 Stability and reactions of CFCs
2.10 Harmful effects of CFCs
2.11 CFCs substitutes
2.12 Bhopal gas tragedy
Ref. 1, Ref. 3, Ref. 5

Aims and Objectives-
Students should know-
i. Segments of atmosphere

ii. Hazards of flue gases
iii. Ozone depletion
iv. Ecological changes due to hazardous gases
v. Understand the social issues

Chapter 3: Hydrosphere and water pollution (08)

3.1 Water resources
3.2 Physical chemistry of sea water: composition, equilibria, pH, pE
3.3 Microbially mediated aquatic reactions, nitrogen cycle, iron and manganese bacteria
3.4 Classification of water pollutants
3.5 Organic and Inorganic pollutants: Pesticides, Detergents, Eutrophication, Marine, Oil, Acid mine drainage, remedial measures and sediments
3.6 Thermal pollution
3.7 Sampling and monitoring water quality parameters: pH, D.O. (Winkler Method), COD, TOC, Total hardness, free chlorine.
Ref. 1, 2, 3, and 5

Aims and Objectives-

Students should know-
i. Water resources
ii. Quality of potable water
iii. WHO limits for toxic materials in water stream
iv. Quality measures

Chapter4. Introduction to Green Chemistry [10]

4.1 Chemistry is good
4.2 The environment and the five environmental spheres
4.3 What is environmental Chemistry?
4.4 Environmental Pollution
4.5 What is green Chemistry?
4.6 Green Chemistry and synthetic chemistry
4.7 Reduction of risk: Hazard and exposure
4.8 The risk and no risks
4.9 Waste prevention
4.10 Basic principles of green chemistry
4.11 Examples based on green technology

[Ref: Green Chemistry By Stanley E Manahan, Chemchar Research Inc. (2006) -2nd Edn. chapter 1, P1-17 and Ref.6 Relevant pages.]

Chapter 5. Green Chemistry and Technology for sustainable development [10]

5.1 Green Chemistry from theory to practice
5.2 The twelve principles of green chemistry
5.3 Green Chemistry and sustainable Development
5.4 Designing Products under the holistic approach " Cardle-to Cardle"
5.5 Scientific areas for practical applications of green chemistry
5.6 Use of alternative basic chemicals as feedstocs in chemical industry and research

5.7 Green Chemistry and Reduction of solvent Toxicity (Alternative Solvents or replacement)
5.8 Applications of New Methodologies in the synthesis of chemical compounds- catalysis and green chemistry.

[Ref : Green Chemistry–Green engineering by AthanasiosValavanidis and ThomaisVlachogianni (March 2012) ; Chapter 2 p17-37 and Ref.6 Relevant pages]

Chapter 6. Green Chemistry and Hazardous Organic Solvents (Green solvents, replacement and Alternative techniques) [04]

6.1 Introduction to Green Chemistry and Toxic organic solvents
6.2 Green solvents and Alternative methods
6.3 Green Chemistry, Green solvents – Alternative techniques in organic synthesis
[Ref : Green Chemistry –Green engineering , Chapter 5, p81-91, Ref.6 Relevant pages]

Aims and Objectives-(for Chapters 4, 5 and 6)

Students should know-

i. Need of green chemistry technology
ii. Principles of green chemistry
iii. Advantages of green chemistry
iv. Simple examples to clarify the principles
v. Catalytic routes for sustainable developments

Reference Books:

1: Environmental Chemistry – A. K. De, 5th Edition (New age international publishers)
2: Environmental Chemistry – J. W. Moore and E. A. Moore (Academic Press, New York)
3: Environmental Chemistry – A. K. Bhagi and C. R. Chatwal (Himalaya Publishing House)
4: Analytical Chemistry – G. D. Christian 4th Edition (John Wiley and Sons)
5: Environmental Chemistry – H. Kaur 2nd Edition 2007, PragatiPrakashan, Meerut, India
6. Environmental Chemistry with Green Chemistry A. K Das , Books and Allied (P) Ltd, and

Semester-III
Course: Environmental and Green Chemistry (CH-346D)

Name of the Topic	Number of lectures
1.Water treatment and effluent management	08
2.Soil and solid waste management	04
3. Instrumental methods in environmental analysis	08
4. Green House Effect and Global Warming	04
5. Water the ultimate Green solvent	12
6. Energy Relations	12
Total lectures	**48**

Chapter 1: Water treatment and effluent management [08]

1.1 Domestic sewage, waste water treatment: primary, secondary and tertiary treatments, aerobic, anaerobic and upflow anaerobic sludge bed treatment processes

1.2 Industrial waste water treatment i) filtration method ii) ion-exchange method iii) membrane techniques: ultrafiltration, reverse osmosis and electrodialysis

1.3 Treatment of drinking water

Aims and Objectives-

Students should know-

i. Methods of water purification
ii. Waste water treatment process
iii. Waste water treatment plants

Chapter 2: Soil and solid waste management [04]

2.1 Composition of soil and types of soil.

2.2 Organic and inorganic components of soil

2.3 Acid base and ion exchange reactions in soil and pH of soil

2.4 Chemistry of disposal of solid waste i) sanitary landfills ii) incinerators iii) pyrolysis

Ref.1, Ref. 2, Ref. 3

Aims and Objectives-

Students should know-

i. Types of soil
ii. Components of soil
iii. Types of solid waste and their disposal

Chapter 3: Instrumental methods in environmental analysis [08]

3.1 Atomic absorption spectroscopy: determination of Hg, As, Zn, Ag, Pb, Mn, Fe, Cu, Cr, Cd

3.2 Gas chromatography: detection and determination of CO, HC and pesticides

3.3 HPLC: determination of pesticides, PAH as metabolites

3.4 Spectrophotometry: determination of NOx, SO_2, NH_3, CN, PO_4, Cd, Pb, Hg

3.5 Chemiluminescence: determination of NOx and O_3.

3.6 Non Dispersive IR spectrometry of determination of CO
3.7 Ion selective electrodes: determination of NO_3 and dissolved oxygen (D. O.)
[Ref. 1, Ref. 2]

Aims and Objectives-
Students should know-

i. Techniques used to monitor hazardous materials present in environment

Chapter 4: Green House Effect and Global Warming [04]
4.1 Introduction
4.2 Greenhouse gases
4.3 Radiative forcing
4.4 Sources and sinks of CO_2
4.5 Causes of fluctuations in global temperature
4.6 Global warming and climate changes
4.7 Implications of climate changes
[Ref. 5]

Aims and Objectives-
Students should know-

i. Green house gases and their effects
ii. Global warming
iii. Climate change

Chapter 5. Water the ultimate Green solvent [12]
5.1 H_2O : Simple formula and complex molecule
5.2 Important properties of water
5.3 The hydrologic cycle
5.4 Bodies of water and life in water
5.5 Chemical process in water
5.6 Fizzy water from underground
5.7 Oxygen in water
5.8 Weak acid from sky
5.9 Why natural water contains alkalinity and calcium
5.10 Metals in water
5.11 Water interactions with other phases
[Ref: Green Chemistry By Stanley E Manahan, Chemchar Research Inc. (2006)-2nd Edn Chapter 7 : P 161-173]

Aims and Objectives-
Students should know-

i. What do you mean by green solvent
ii. Resources of of green solvents like alcohol and water
iii. Importance of water as a green solvent

Chapter6 .Energy Relations : [12]
6.1 Energy

6.2 Radiant Energy from the sun
6.3 Storage and release of energy by chemicals
6.4 Energy sources
6.5 Conversions between forms of energy
6.6 Green engineering and energy conversion efficiency
6.7 Conversion of chemical energy
6.8 Renewable energy sources

[Ref: Green Chemistry By Stanley E Manahan, Chemchar Research Inc. (2006) -2nd Edn Chapter 6 : P 135-157]

Aims and Objectives-

Students should know-

i. Natural resources of energy
ii. Conventional and nonconventional energy resources
iii. Conservation of energy
iv. Utilization of solar and wind energies.

Reference Books:

1: Environmental Chemistry – A. K. De, 5th Edition (New age international publishers)
2: Environmental Chemistry – J. W. Moore and E. A. Moore (Academic Press, New York)
3: Environmental Chemistry – A. K. Bhagi and C. R. Chatwal (Himalaya Publishing House)
4: Analytical Chemisry – G. D. Christian 4th Edition (John Wiley and Sons)
5: Environmental Chemistry – H. Kaur 2nd Edition 2007, PragatiPrakashan, Meerut, India
6. Environmental Chemistry with Green Chemistry A. K Das , Books and Allied (P) Ltd.

Semester-III

Course: Agriculture Chemistry (CH-336E)

Name of the Topic	Number of lectures
1. Soil Chemistry	10
2. Problematic Soil and Soil testing	10
3. Quality of Irrigation Water	08
4. Plant Nutrients	08
5. Fertilizers and Manures	06
6. Protection of Plants	06
Total lectures	**48**

Chapter I –Soil Chemistry (10 L)

1.1 Role of agriculture chemistry
1.2 Scope and importance of agricultural chemistry
1.3 Agricultural chemistry and other science
1.4 Definition of soil, Soil components-mineral component, organic matter or humus, soil atmosphere, soil water, soil microorganism
1.5 Physical properties of soil- soil texture, soil structure, soil color, soil temp, soil density, porosity of soil.
1.6 Surface soil and sub-soil
1.7 Chemical properties of soil, soil reactions and solutions
1.8 Factor controlling soil reaction, buffering capacity, importance of buffer action in agriculture, ion exchange
Ref 1- Pagers 8-12, 92-94, 98-113, 116-146
Ref 3- Pages 28-50

Chapter II – Problematic Soil and Soil testing (10 L)

2.1 Acid soil- formation of acid soil, effect of soil acidity of soil, reclamation of acidic soil
2.2 Alkali Soil- formation of alkali soil, reclamation of alkali soil
2.3 Classification of alkali soil- saline soil, saline alkali soil, non-saline alkali soil
2.4 Calcareous soils
2.5 Introduction to soil testing
2.6 Objectives of soil testing
2.7 Phases of soil testing- collection of soil sample, analysis in the laboratory and fertilizer applications
Ref 1- 345-370, Ref 3- 301-312, Ref 4- 135-147 and 150-159

Chapter III- Quality of Irrigation Water (08 L)

3.1 Sources of Water- Atmospheric water, Surface Water, Stored Water, Ground Water
3.2 Impurities in Water, Water quality, related problems in public health, environment and agriculture

3.3 Analysis of irrigation Water (ppm, meq/lit.epm)
3.4 Dissolved constituents and their functions
Major constituents- Ca, Mg, Na, K, Carbonate, bicarbonate, sulfate, Chloride and nitrate
Minor constituents- B, Si, nitrite, Sulfide and fluoride
3.5 Water quality standard- total soluble salt (TSS), sodium adsorption ratio (SAR), Exchangeable sodium percentage (ESP), Residual sodium carbonate, salinity classes for irrigation water
Ref 8- Pages 293-309

Chapter IV- Plant Nutrients (08 L)
4.1 Need of plant nutrients, forms of nutrients updates, nutrient absorption by plants
4.2 Classification of essential nutrients
4.2.1 Primary nutrients (N, P, K), its role and deficiency symptoms in plants
4.2.2 Secondary nutrients, (Ca, Mg, S), its role and deficiency symptoms in plants
4.2.3 Micronutrients, General functions of micronutrients (Zn, Fe, Mn, Cu, B, Mo, Cl)
4.3 Effect of environmental condition, nutrient uptake
Ref 3- Pages 207-241, Ref 4- Pages 176-195, Ref 7- pages 287-300

Chapter V- Fertilizers and Manures (06 L)
Fertilizers
5.1 Introduction, Classification & application of fertilizers
5.2 Time and methods of fertilizers
5.3 Factors affecting efficiency of fertilizers
5.4 Vermicompost preparation, effect of vermicompost on soil fertility

5.5 Synthetic fertilizers definition, comparison of synthetic fertilizers with organic fertilizers , environmental effect of synthetic fertilizers
Manures
5.6 Introduction, Definition and classification of manures
5.7 Effect of bulky organic manures on soil, farm yard manures (FYM), Factors affecting on FYM, method of preparation, losses during handling and storage
5.8 Biogas plant. Human waste, sewage and sludge, types of sludge, carbon nitrogen ratio, sewage irrigation and uses
5.9 Green manuring, types of green manuring, characteristics, advantages and disadvantages of green manuring

6.0 Biofertlizers: definition, classification, role & advantages

Ref 2- Pages 205-213, Ref 3- 90-112, 137-149

Chapter VII- Protection of Plants (06 L)
Pesticide Classification and mode of action
7.1 Insecticide- Definition, Classification, chemical properties, elemental composition, mode of action of synthetic and plant originated compounds organophosphates, malathion, parathion, carbamates
7.2 Fungicides- Definition, Classification, Chemical properties, mode of action of S

& Cu fungicides
7.3 Herbicides- Definition,, Classification, composition, mode of action of Selective and non-selective herbicides.

Ref 6- Relevant Pages

Learning Objectives of Agriculture Chemistry

After studying this course, student is expected to
1. Know the role of agriculture chemistry and its potential
2. Understand basic concept of soil, properties of soil & its classification on the basis of pH
3. Know the different plant nutrients, Their functions and deficiency symptoms
4. Understand importance of manures as compared to chemical fertilizers'
5. Understand the importance of green manuring
6. Have the knowledge of the use of proper the plants
7. Know various techniques to protect the plants
8. Have the knowledge of various pesticides, insecticides, fungicides and herbicides
9. Identify the problematic soil and recommend method for their reclamation
10. Have the knowledge of quality irrigation water, water quality standard and analysis of irrigation water

Reference Books

1. A text book of soil science (Recise Ed) J.A. Daji, Revised by J.R. Adam, N.D. Patil, Media promoters and publishers, Mumabi, 1996
2. Text book of soil science, T.D. Biswas, S.K. Mukharjee, Tata McGraw Hill Publishing company, New Delhi
3. Introduction to Agronomy and soil, water management, V.G. Vaidya, K.R. Sahashtra Buddhe (Continental Prakashan)
4. Principals of soil science, M.M. Rai, Millian complex of India, Bombay, 1977
5. Manures and fertilizers (sixth ed), K.S. Yawalkar, J.P. Agarwal and Bokde, Agrihorticulture publishing house, Nagpur, India
6. Chemistry of insecticides and fungicides, U.S. Sreeramula (2nd Ed), oxford and IBH Publishing company, New Delhi
7.Fundamentals of soil sciences, C.E. Millar and L.M. Turk, Bio-Tech- New Delhi (1st Ed 2001)
8. Soil, Plant, Water and fertilizer analysis, P.K. Gupta, Published by Agro Botanica
9. **Biofertilizers** and biopesticides , Author: Deshmukh, A. M. (ArvindMadhavrao),

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Semester-IV

Course: Dairy Chemistry (CH-336E)

Name of the Topic	Number of lectures
1. Market Milk	08
2. Common Dairy Processes	06
3. Special Milks	08
4. Milk proteins, Carbohydrates and Vitamins	08
5. Preservatives & Adulterants in Milk	06
6. Milk Products	08
7. Dried Milk Products	04
Total lectures	**48**

Chapter I – Market Milk (08 L)

Introduction, Definition, constituents of milk of different species such as cow, buffalo, goat, etc., Chemical composition of milk of Indian breed and foreign breeds of cow, factor affecting composition of milk, characteristics of milk of different mammals, physicochemical properties of milk, acidity, pH, density, specific gravity, color and flavor of milk, food and nutritive value of milk. Microbiology of milk, growth of microorganism, stages of growth, product of microbial growth, destruction of microorganisms growth.

Ref 1 chap I relevant pages, Ref 2 pages 9-26, Ref 6 – relevant pages.

Chapter II – Common Dairy Processes (06 L)
(Manufacture, storage and packaging)

Cream separation- Basic principles, gravity creaming water dilution and centrifugal creaming method, construction of centrifugal separator, factors affecting percentage of fat, speed of machine, temp. of milk, rate of inflow amount of flushing water formation of separator slime Pasteurization of milk, flow sheet diagram, process receiving milk, preheating filtration, clarification, cooling and storage raw milk, standardization, pasteurization, homogenization, packing and storage, uses of milk.

Ref 1.- Relevant pages.

Chapter- III Special Milks (08 L)

1. Sterilized milk- Definition, method of manufacture in detail, Advantages and disadvantages. 2. Homogenized milk,- Definition, merits and demerits factor influencing homogenization, Process of manufacture. 3. Soft curd milk- Definition, characteristics, method of preparation of soft curd milk. 4. Flavored milk- Definition, types, method of manufacture flow sheet diagram. 5. Vitaminised / irradiated milk- - Definition, method of manufacture. 6. Fermented milk-Definition, method of manufacture. 7. Standardized milk- Definition, method of manufacture.

Ref 1 Chap II relevant pages.

Chapter IV- Milk proteins, Carbohydrates and Vitamins (08 L)

1. Milk proteins- importance of proteins found in the milk-casein, albumin and globulin, composition, nomenclature, properties and uses. 2. Carbohydrates- importance of lactose, classification, properties, nutritive value of lactose use of lactose. 3. Vitamins- importance, definition,

properties nutritive value of vitamins, Vit-A, Vit-B, B2, B6, B12, Vit-C (Ascorbic acid) & Vitamin-D. 4. Food and nutritive value of milk, milk & public health.

Ref-2 Pages 11,12,33 to 38, 42 to 49, 51 to 53

Chapter V- Preservatives & Adulterants in Milk (06 L)

1. Preservation of milk- Introduction, Common preservatives are used. 2. Adulterants- Introduction, Modes of Adulteration and their detection such as skimming, addition of separated milk, skim milk, Water, Starch and cane sugar.

Ref -2 Pages 78-81

Chapter VI- Milk Products (08 L)

Cream, Butter, Cheese and Ice-Cream.

1. Cream- Definition, Classification, Composition, Food & Nutritive value, Physicochemical properties, Manufacture and uses of cream. Ref-1 117, 118, 121 & 142

2. Butter- Definition, Classification, Composition, Food & nutritive value, Physicochemical properties, Manufacture and uses of Butter selection of milk/cream. Preheating of milk, Separating of milk, neutralization of cream, Pasteurization of cream, Cooking & ageing, repending of cream, salting of butter, washing of butter, packaging & Storage, use of butter.

Ref -1 Pages 143, 144, 145 to 158 & 173

3. Cheese- Definition, Classification, Food & nutritive value, properties, Manufacture and uses of cheese.

Ref -1 Pages 224, 227, 229 to 242 & 267

4. Ice-cream- Definition, Classification, Composition, Food & Nutritive value, Manufacture, packing, hardening & Storage, uses of Ice-cream.

Ref -1 Pages 182, 183, 184, 193,223

Chapter VII- Dried Milk Products (04 L)

Introduction, butter milk powder, whey powder, cream powder, infact milk powder, Shrikand powder, Ice-cream mix powder, cheese powder.

Ref-1 Pages 357 to377

Learning Objectives-

The students are expected to study “Dairy Chemistry” in view of-

1. Knowing importance of the subject from the point of rural economy.
2. Knowing the composition of milk, its food & nutritive value
3. Understanding the Microbiology of the milk
4. Understanding various preservation and adulterants, various milk proteins and their role for the human body.
5. Knowing various milk products, their composition, manufacture and uses.

References-

Ref- 1: Qutline of Dairy Technology- Oxfored University press By- Sukumar De. (Edition-1983)

Ref- 2: Dairy Chemistry and Animal Nutrition- M.M. Rai, Kalyani, Publishers, New Delhi 3rd Edition, 1980
Ref- 3: Fundamentals of Dairy Chemistry- B.H. Webb, A.H. Hohsson, J.A. Alford, CBB Publishers and Distributors.
Ref- 4: Milk and Milk Products- C.H. Eckles, H. Macy, Tata McGraw Hikk Publishing Company Ltd.
Ref- 5: Chemistry and Testing of Dairy Products- H.V. Athertion, J.A. New Lander, CBS, Publishers and Distributors.
Ref-6: Dairy Microbiology, Dr. K.C. MahantaOmsons Publication New Delhi.
