Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati, Dist. Pune.
(Autonomous)
Affiliated to Savitribai Phule Pune University, Pune.
Department of Chemistry
T.Y. B. Sc. Chemistry Syllabus
To be implemented from Academic Year 2021-2022 (June 2021)

Semester	CourseCodeandTitle of the paper	Number of Credits	Max. Marks (Int.+Ext.= Total)
V	**THEORY PAPERS**		
	CHEM -3501:PhysicalChemistry- I	**03**	**40 + 60 = 100**
	CHEM -3502: InorganicChemistry-I	**03**	**40 + 60 = 100**
	CHEM -3503: OrganicChemistry-I	**03**	**40 + 60 = 100**
	CHEM -3504: AnalyticalChemistry-I	**03**	**40 + 60 = 100**
	CHEM -3505: IndustrialChemistry-I	**03**	**40 + 60 = 100**
	OPTIONALTHEORY PAPER (Select *ANY ONE* of the following)		
	CHEM- 3506 (A)NuclearChemistry- I	**03**	**40 + 60 = 100**
	CHEM- 3506 (B)Polymer Chemistry-I		
	CHEM- 3506 (C)IntroductiontoBiochemistryandMolecularBiology-I		
	CHEM- 3506 (D)EnvironmentalandGreenChemistry-I		
	CHEM- 3506 (E) Agriculture Chemistry		
	CHEM- 3506 (F) Synthesis of Nanomaterials and Nano toxicology		
	PRACTICAL PAPERS		
	CHEM- 3507 :PhysicalChemistryPractical-I	**02**	**40 + 60 = 100**
	CHEM- 3508 :InorganicChemistryPractical- I	**02**	**40 + 60 = 100**
	CHEM- 3509 :OrganicChemistryPractical - I	**02**	**40 + 60 = 100**
VI	**THEORY PAPERS**		
	CHEM -3601:PhysicalChemistry- II	**03**	**40 + 60 = 100**
	CHEM -3602: InorganicChemistry-II	**03**	**40 + 60 = 100**
	CHEM -3603: OrganicChemistry-II	**03**	**40 + 60 = 100**
	CHEM -3604: AnalyticalChemistry-II	**03**	**40 + 60 = 100**
	CHEM -3605: IndustrialChemistry-II	**03**	**40 + 60 = 100**
	OPTIONALTHEORY PAPER (Select *ANY ONE* of the following)		
	CHEM- 3606 (A)NuclearChemistry-II	**03**	**40 + 60 = 100**
	CHEM- 3606 (B)Polymer Chemistry-II		
	CHEM- 3606 (C)IntroductiontoBiochemistryandMolecularBiology-II		
	CHEM- 3606 (D)EnvironmentalandGreenChemistry-II		
	CHEM- 3606 (E) Dairy Chemistry		
	CHEM- 3606 (F) EnvironmentalNanotechnology andApplications		
	PRACTICAL PAPERS		
	CHEM- 3607: PhysicalChemistryPractical-II **OR** CHEM- 3607 (P): Project work Physical Chemistry	**02**	**40 + 60 = 100**
	CHEM- 3608: InorganicChemistryPractical-II **OR** CHEM- 3608 (P): Project work Inorganic Chemistry	**02**	**40 + 60 = 100**
	CHEM- 3609: OrganicChemistryPractical – II **OR** CHEM- 3609 (P): Project work Organic Chemistry.	**02**	**40 + 60 = 100**

Note: In semester VI, it is mandatory for every student to select two practical papers and remaining one project paper.

Semester V

CHEM 3501: Physical Chemistry – I, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	Investigation of Molecular Structure	16
2	Electrolytic conductance	14
3	Photochemistry	12
4	Colloids	06

Learning objectives:

- The students are expected to know, the term molar refraction, meaning of electrical polarization of molecule, meaning of induced and orientation polarization, concept of dipole moment and its experimental determination by temperature variation method, Application of dipole moment for structure determination.
- The students are expected to learn, Rotational / Microwave spectroscopy, Derivation for rotational spectra for the transition from J to J+1, Limitations of Rotational Spectra, Vibrational Spectra, Vibrational rotational Spectra, Raman Spectroscopy.
- The students are expected to know, Ohm's law and electrical units such as coulomb, Ampere, Ohm and Volt, Meaning of specific resistance, specific conductance, cell constant and their units, Cell constant, its theoretical and experimental determination.
- The students are expected to become familiar to Preparation of conductivity water, Experimental determination of conductance, Variation of specific and equivalent conductance of strong and weak electrolyte withdilution, Meaning of infinitely dilute solution.
- The students are expected to understand, Kohlrausch's law of independent migration of ions and its applications such equivalentconductance of weak electrolyte at zero conc., degree of dissociation (α), ionic product of water, Transport number of an ion, Hittorf's rule, Experimental determination of transport number by Hittorf's and moving boundarymethod.
- The students are expected to explain, Drawbacks of Arrhenius theory, Debye-Huckel-Onsager Interionic Attraction theory, Asymmetry /Relaxation effect, Electrophoretic effect, Validity of Onsager equation, Fugacity and activity concept, Activity and activity coefficient of strong electrolyte.
- The students are expected to know, Interaction of radiation with matter, difference between thermal and photochemical processes, different laws of photochemistry, Jablonski diagram, qualitative description of fluorescence, phosphorescence, non- radiative processes,quantum yield, photosensitized reactions,Kinetics of Photo chemical reaction,
- The students are expected to understand, colloidal system, classification of colloids, lyophobic and lyophilic sols, Tyndall effect, Brownian movement, Determination of size of colloidal particles, surfactants, emulsions, gels, importance and applications of colloids.
- The students are expected to solve the numerical problems on relevant topics.

Learning outcomes:

- Knowing the various terms such as molar refraction, electrical polarization of molecule, induced and orientation polarization, dipole moment and its experimental determination, Application of dipole moment for structure determination.
- Understanding the Rotational / Microwave spectroscopy, Derivation and Limitations of Rotational Spectra, Vibrational Spectra, Vibrational rotational Spectra, Raman Spectroscopy.

- Knowing the various terms such asspecific resistance, specific conductance, cell constant, its units and theoretical and experimental determination, conductivity water, equivalent conductance, Variation of specific and equivalent conductance with dilution, equivalent conductance at infinite dilution.
- Learning the Kohlrausch's law of independent migration of ions and its applications Transport number and its experimental determination, Hittorf's rule., Debye-Huckel-Onsager Interionic Attraction theory, Validity of Onsager equation, Fugacity and activity concept, Activity and activity coefficient of strong electrolyte.
- Knowing the interaction of radiation with matter, thermal and photochemical processes, laws of photochemistry, Jablonski diagram, fluorescence, phosphorescence, non- radiative processes, determination of quantum yield, photosensitized reactions, Kinetics of photo chemical reaction,
- Understanding the meaning of colloidal system, types of colloids, lyophobic and lyophilic sols, Tyndall effect, Brownian movement, surfactants, emulsions, gels, importance and applications of colloids.
- Imparting and improving the ability of students towards thinking, reasoning and solving the numerical based on related topics.

Unit 1: Investigation of Molecular Structure (16 L)

Molar refraction, Electrical polarization of molecules, Permanent dipole moment, Determination of dipole moment, Rotational spectra of diatomic molecules, intensities of spectral lines, vibrational spectra of diatomic molecule, rotational vibrational spectra of diatomic molecule, selection rule. Born- Oppenheimer approximation, quantum and classical theory of Raman spectra, Raman effect, pure rotational Raman spectra, Numericals.

Unit 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 Equivalent conductance at infinite dilution of a weak electrolyte, The ionic product of water, 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-Hückel-Onsager equation and its validity, Activity in solution, fugacity and activity coefficient of strong electrolyte, Conductometric titrations, Numericals.

Unit 3: Photochemistry (12 L)

Interaction of radiation with matter, difference between thermal and photochemical processes, Laws of photochemistry: Grotthuss – Draper law, Stark – Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions – energy transfer processes (simple examples), Kinetics of Photo chemical reaction, Numericals.

Unit 4: Colloids (06 L)

Types of colloidal system, classification of colloids, lyophobic and lyophilic sols, preparation of colloidal solution, Tyndall effect, Brownian movement, Determination of size of colloidal particles, surfactants, emulsions, gels, importance and applications of colloids.

Reference books

1. Principles of Physical Chemistry, S.H. Marron and C.F. Prutton, 4 th edn
2. Essentials of Physical Chemistry, B. S. Bahl, G.D Tuli- Revised multicolor edn 2009.S Chand
3. Physical Chemistry- a molecular approach, Donald A. McQuarrie, John D. Simon.
4. Physical Chemistry, G. M. Barrow, Fifth edn.

CHEM 3502: Inorganic Chemistry – I, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	Werner's theory of Coordination Compounds	04
2	Isomerism in Coordination Complexes	06
3	Sidgwick Theory	06
4	Pauling's Valence Bond Theory	08
5	Crystal Field Theory	10
6	Molecular Orbital Theory of Coordination Complex	08
7	Concept and Scope of Ligand Field Theory	06

Learning objectives:

- Students should know meaning of various terms involved in coordination chemistry, different types of Ligands. chelating agents, chelate and stability of chelates and complexes, charge on complex ion and the oxidation number. IUPAC name and application the co-ordination compounds in biology and chemistry.
- Students able to understand the Werner's formulation of complexes and identify the ionizable ions, to distinguish between ionizable and non-ionizable valencies with suitable examples, to draw the geometrical and optical isomerism of complexes, to define and explain various types of isomerism in complexes.
- Students able to choose the correct geometry for complexes with C.N. 4 and C.N. 6 with the help of stereoisomerism, to define EAN rule and calculate EAN value of the complexes and give comment on EAN value and stability of complexes.
- Students should know the merits and the demerits of Sidgwick's theory, involvement of d-orbitals in hybridization during formation of square planar, tetrahedral, trigonal bi-pyramidal and octahedral complexes.
- Students able to explain structure and magnetic behavior of the complexes, to identify the high spin and low spin complexes, to identify inner orbital and outer orbital complexes, to explain elctroneutrality principle and different types of pi bonding.
- Students should know the limitations of VBT, the shapes of d-orbitals and degeneracy of d-orbitals, the assumptions of CFT.
- Students able to understand how splitting of d-orbitals occurs when ligand approaches, to draw crystal field splitting diagrams of d orbital of metal ion in octahedral, tetrahedral, square planer or tetragonal ligand field, to Interpret the spectra of complexes and calculate the 10 Dq, to understand the factors affecting magnitude of 10 Dq.
- Students able to find high spin and low spin complexes when 10 Dq and pairing energy are given, to explain d-d transitions and color of the complexes, to Know the conditions under which Jahn-Teller distortion occurs.
- Students able to explain the details about reason for Jahn-Teller distortion occur in octahedral complexes, Nephelauxatic effect towards covalent bonding, MOT of Octahedral complexes with sigma bonding and Charge Transfer Spectra.
- Students able to compare the different approaches to bonding in coordination compounds.

Learning outcomes:

- Knowing the various terms involved in coordination chemistry, application the co-ordination compounds.
- Understanding the Werner's theory and various types of isomerism in complexes.
- Selecting the correct geometry for complexes with C.N. 4 and C.N. 6 with the help of stereoisomerism.
- Use of EAN rule to calculate EAN value of the complexes and relationship between EAN value and stability of complexes.

- Knowing the details of Sidgwick's theory and formation of square planar, tetrahedral, trigonal bi-pyramidal and octahedral complexes.
- Identifying the structure and magnetic behavior of the complexes, the high spin and low spin complexes, the inner orbital and outer orbital complexes, elctroneutrality principle and different types of pi bonding.
- Knowing the limitations of VBT, the shapes of d-orbitals and degeneracy of d-orbitals, the assumptions of CFT, crystal field splitting diagrams, calculation of 10 Dq value.
- Knowing the details about high spin and low spin complexes, d-d transitions and color of the complexes, Jahn-Teller distortion, Nephelauxatic effect towards covalent bonding, MOT of Octahedral complexes with sigma bonding and Charge Transfer Spectra.
- Understanding the different approaches to bonding in coordination compounds.

Coordination Chemistry

Unit 1: Werner's theory of Coordination Compounds (04 L)

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

Unit 2: Isomerism in Coordination Complexes (06 L)

Definition of isomerism in Complexes-Structural Isomerism and stereoisomerism,

- Structural isomerism (ionization, hydrate, linkage, ligand, coordination position and polymerization isomers)
- Stereoisomerism and its Types-Geometrical isomerism and optical isomerism.

Unit 3: Sidgwick Theory (06 L)

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

Unit 4: Pauling's Valence Bond Theory (08 L)

Introduction of Valence Bond Theory (VBT), Need of concept of hybridization, Aspects of VBT, Assumptions, VB representation of tetrahedral, square planer, trigonal Bi-pyramidal and octahedral complexes with examples, Inner and outer orbital complexes, Electro neutrality principle, Multiple bonding ($d\pi$-$p\pi$ and $d\pi$-$d\pi$), Limitations of VBT.

Unit 5: 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 Nephelauxatic 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)

Unit 6: Molecular Orbital Theory of Coordination Complex (08 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.

Unit 7: Concept and Scope of Ligand Field Theory (06 L)

Free ion configuration, Term and states, Energy levels of transition metals, free ion term, Term wave function, Spin orbit coupling,

Reference Books

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

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CHEM 3503: Organic Chemistry – I, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	Strength of organic acids and bases	07
2	Stereochemistry of di-substituted cyclohexane	06
3	Nucleophilic Substitution at Aliphatic Carbon	08
4	Elimination Reaction	06
5	Aromatic Electrophilic and Nucleophilic substitution reactions	10
6	Carbanion and Their Reactions	06
7	Green Chemistry	05

Learning objectives:

- Students should know – Definition and types of organic acid and base, the pka and pkb concepts. Effect of temperature on pka /pkb and comparison between strengths of acids/bases.
- Students should learn –To distinguish between geometrical and optical isomerism and know about stability, energy calculations with potential energy diagram and optical activity of these conformers.
- Students should understand –Different types of nucleophilic substitution reactions, the kinetics, mechanism & stereochemistry of these reactions, whether a given reaction follows SN_1 or SN_2 mechanism and the comparison between SN_1& SN_2 reactions.
- Students should learn –Statement of Hoffmann and Saytzeff rule, the evidences, mechanism & stereo chemical aspects of these reactions and whether a given reaction follows E1, E2 or E1cB mechanism.

- Students should understand – An Arenium ion and Ipso substitution, the evidences, reactivity and mechanism of these reactions and whether a given reaction follows Addition-Elimination or Elimination-addition mechanism.
- Students should know – Possible mechanism of some known name reactions involving carbanions and synthetic applications some reagents.
- Students should know – Principles of green chemistry, examples of green solvents and safer solvents and chemical syntheses by using less hazardous chemicals.

Learning outcomes:

- Understanding the strength i.e strong or weak acid or base and factors responsible for their strength.
- Learning stereochemistry of the di-substituted cyclohexane with their stereoisomers and stability.
- Knowing the kinetic, mechanism and stereochemistry of aliphatic substitution reactions and differences between them.
- Understanding types of elimination reaction with mechanism. Understanding a particular elimination reaction follow particular path.
- Learning and knowing an aromatic compound shows mostly electrophilic substitution reactions. Under special condition also shows some nucleophilic reactions. Effect and orientation of mono-substituted aromatic compounds.
- Knowing formation and stability with some reactions involving carbanion as intermediate.
- Understanding principles and importance of green route for organic synthesis by concerning environmental issues.

Unit 1. Strength of organic acids and bases. (07 L)

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, acid and bases catalysis.

Ref. 5: Pg. -53-75, Ref. 4: Relevant pages.

Unit 2. Stereochemistry of di-substituted cyclohexane. (06 L)

Introduction, 1,1-alkyl substituted cyclohexane, 1,2; 1,3; 1,4-di methyl cyclohexane- geometrical isomerism, optical isomerism, Stability of conformation, Energy calculation.

Ref. 1: Relevant pages, Ref. 3: Pg. 204-214.

Unit 3. Nucleophilic Substitution at Aliphatic Carbon (08 L)

Introduction, Nucleophiles and leaving groups, Mechanism of nucleophilic substitution, The S_N1 reaction: Kinetic, mechanism and stereochemistry, stability of carbocation, The S_N2 reaction: Kinetic, mechanism and stereochemistry. How to know whether a given reaction will follow S_N1 or S_N2 mechanism, S_Ni reaction and mechanism.

Ref. 1: Pg. 172-203, 208-201, Ref. 5: Relevant pages.

Unit 4. Elimination Reaction. (06 L)

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.

Ref. 1: Pg. -53-75, Ref. 2: Relevant pages.

Unit 5. Aromatic Electrophilic and Nucleophilic substitution reactions (10 L)

Introduction, Arenium ion mechanism, Effect of substituent groups (orientation, o/p directing and meta directing groups), Classification of substituent groups (activating and deactivating group). Mechanism of nitration, sulphonation, halogenation, Friedel-Craft reactions, diazo-coupling reactions, Ipso substitution. Addition elimination (S_NAr), S_N1, Elimination- addition (benzyne) S_NR1 reactions, reactivity.

Ref. 1: Pg.- 517-544, 666-667, Ref. 4 and 5: Relevant pages.

Unit 6. Carbanion and Their Reactions (06 L)

Introduction, Formation and stability of carbanion, Reaction involving carbanions and their mechanism- Aldol, Claisen, Dieckman and Perkin condensation; Synthesis and synthetic applications of –Wittig reagent.

Ref. 5: Pg.-270-299.

Unit 7. Green Chemistry: (05 L)

Introduction, twelve principles of green chemistry, Green solvents, Atom economy, less hazardous chemical synthesis, Designing safer chemicals, Safer solvents and auxiliaries.

Ref. 6: 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 MC Grow Hill 1989.
4. Organic Chemistry by Clayden, Greeves, Warren and Wothers (Oxford press)
5. A guide book of reaction mechanism by Peter Sykes 5thEdn.
6. New Trends in Green Chemistry- V.K. Ahluwalia, M. Kidwai

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CHEM 3504: Analytical Chemistry – I, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	Gravimetric Analysis	12
2	Thermal methods of analysis	06
3	Spectrophotometry	10
4	Polarography	08
5	Flame Emission Spectroscopy	06
6	Atomic Absorption Spectroscopy	06

Learning objectives:

- The students are expected to learn, Principles of common ion effect and solubility product, Formation of complex ion, Factors affecting on solubility of precipitation, Phenomenon of super saturation and precipitation, meaning of co-precipitation and post precipitation, Choice of liquid for washing the precipitate, Precautions during filtration, drying and ignition of precipitate, Conceptual understanding of electrogravimetric principle.
- The students are expected to know, Methods of thermo gravimetric analysis, Principles of TGA and DTA, Types of TGA, Relation between TGA and DTA, Thermal equation of TGA, Different factors affecting TGA curve, Determination of calcium oxalate precursor, Applications of TGA, DTA and DSC.
- The students are expected to learn, Principles of Spectrophotometric analysis and properties of electromagnetic radiations, Different Terms like absorbance, transmittance, and molar absorptivity, Statement and derivation of Lambert's Law and Beer's Law, Different wavelength selectors and their importance, Instrumentation and working of single and double beam spectrophotometer, Additivity Principle, Different methods of color comparators, Applications.
- The students are expected to know, Voltammetry and polarography as an analytical tool, Construction, working, advantages and disadvantages of DME, Different terms involved in Ilkovic

equation, Determination of Zn and Cd from the mixture, Significance of the different terms involved, Need of removal of dissolved oxygen from analyte solution, Applications.

- The students are expected to learn, Emission spectroscopy as an analytical tool, Measurement of emission of atomic species, Different methods of analysis, Applications.

- The students are expected to know, Atomic absorption spectroscopy as an analytical tool, Measurement of absorbance of atoms by AAS, Interferences in atomic absorption spectroscopy, Applications.

Learning outcomes:

- Learning and knowing details about common ion effect and solubility product, super saturation and precipitation, electrogravimetric principle, numerical on gravimetric estimation.
- Knowing the Methods of TGA and DTA. Thermal equation of TGA, Different factors affecting TGA curve, Applications of TGA, DTA and DSC. Related numerical.
- Learning the principles and terms of Spectrophotometric analysis, Statement and derivation of Lambert's Law and Beer's Law, Instrumentation, working and applications of single and double beam spectrophotometer. Numerical.
- Knowing the Voltammetry and polarography as an analytical tool, Construction, working, advantages and disadvantages of DME. Details about Ilkovic equation. Applications- Determination of Zn and Cd from the mixture. Numericals.
- Learning the details about Emission spectroscopy, methods involves and applications.
- Knowing the AAS as an analytical tool, measurement of absorbance, Interferences in atomic absorption spectroscopy, Applications.

Unit 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

Unit 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.

Ref. 1.Pg. 515-527,531-537, Ref. 6 Pg. 732-737

Unit 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 beam colorimeter, 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

Unit 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. Pg.691-734

Unit 5. 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

Unit 6. 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

Reference books

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

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CHEM 3505: Industrial Chemistry – I, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	Modern Approach to Chemical Industry	08
2	Manufacture of Heavy Chemicals	08
3	Fertilizers	08
4	Sugar Industry and Fermentation Industry	08
5	Cement and Glass Industry	08
6	Small Scale Industries	08

Learning objectives:

- The students are expected to learn; Importance of chemical industry, meaning of the terms involved, comparison between batch and continuous process, knowledge of various industrial acts
- The students are expected to learn Physico-chemical principles involved in the manufacturing process, manufacture of basic chemicals with the help of flow sheet diagram, they should know the applications of these chemicals. To study Manufacture of heavy chemicals in terms of Principle, Flow chart and working.
- The students are expected to learn importance of synthetic and natural fertilizers and NPK ratios, the various manufacturing processes with flow sheet diagram, to study Manufacture of Fertilizers in terms of Principle, flow chart and working.
- The students are expected to learn importance of sugar industry, manufacture of direct consumption (plantation white) sugar with flow diagram. Cane juice extraction by various methods, clarification by processes like carbonation, Sulphonation, phosphotation etc. Concentration of juice by using multiple effect evaporator system, Crystallization of sucrose by using vacuum pan.
- The students are expected to learn importance of fermentation industry Various methods of manufactures, Basic requirement of fermentation process, iii. Manufacturing of ethyl alcohol by using molasses, iv. Food grains, fruits & ethylene.
- The students are expected to learn importance of these industries, manufacture of cement by modern method
- The students are expected to learn about various types of glasses, making of glass by different methods, various operations involved in the manufacture and compositions, properties and uses of glasses.
- The students are expected to learn importance of these industries, to study Manufacture of small-scale industries in terms of Principle, Flow chart and working.

Learning outcomes:

Student able to understand,

- Basic requirements of Chemical Industry, different terms, operations and processes involved in chemical Industry.
- Describe Copy Right Act, Patent Act and Trade Marks, Bureau of Indian Standards (BIS) and International Organization for Standardization (ISO). Page 27 of 70.
- Manufacture of industrial heavy chemicals Learning and understanding of physicochemical principles of production of ammonia, sulfuric acid, nitric acid along with its manufacturing plant.
- Fertilizers different types of fertilizers (N, P and K). Importance of fertilizers, chemistry involved in the manufacture of the following fertilizers: urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates, superphosphate of lime, potassium chloride and potassium nitrate.
- Basic requirements, raw materials, different processes and operations involved in Sugar Industry and also different grades of sugar and uses of by-products of sugar industry.
- Importance of fermented products, basic requirements, theory and process of alcohol making, fractional distillation and various terms involved in Fermentation Industry.
- Basic requirements, raw materials, different processes and operations involved in cement Industry and also burning operation involved in cement industry.
- Basic requirements, raw materials, different processes, and operations involved in the manufacture of glass Industry Importance of glass industry products.
- Basic requirements of small-scale chemical Industry, different chemical products such as Naphthalene balls, Wax Candles, Shoe Polishes, Gum Paste, Writing and fountain Pen ink, Plaster of Paris, along with its manufacturing plant.

Unit 1. Modern Approach to Chemical Industry (08 L)

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, trademarks

Ref.1: Chapter 2 Pg. 26, 27, 31 to 36, Ref.4: Chapter 1 and 2, Ref.6: Chapter 1, 2 and 3

Ref: Websites and Web Pages www.wikipedia.org/wiki/patentact, www.wikipedia.org/wiki/trademarks, www.wikipedia.org/wiki/copyright_act_of1976

Unit 2. Manufacture of Heavy Chemicals (08 L)

Introduction, Manufacture of Ammonia (NH_3) i. Physico-chemical principles ii. Manufacture by Haber's process. Its uses.

Manufacture of Sulphuric acid (H_2SO_4) i. Physico-chemical principles ii. Manufacture by Contact process. Its uses.

Manufacture of Nitric acid (HNO_3) i. Physico-chemical principles ii. Manufacture by Ostwald's (Ammonia oxidation process). Its uses. Ref. 7: Pg. 571 to 588, 618 to 664

Unit 3. Fertilizers (08 L)

Introduction, Plant Nutrients, important of fertilizers, Nutrient functions, Fertilizer types, organic manure, Need for fertilizers, Essential requirements, Classification of fertilizers, inorganic fertilizers, Artificial-fertilizers- Nitrogenous fertilizers Ammonium sulphate, Urea (Manufacture of Urea & Ammonium Sulphate), Action of Ammonium Sulphate & Urea as Fertilizer, Phosphatic Fertilizers- Triple Super Phosphate (Manufacturing Process Only), Potassium fertilizer, Manufacture of mixed fertilizers.

Ref. 5: - Chapter 26

Unit 4. Sugar Industry and Fermentation Industry: (08 L)

Introduction, Important of sugar industry, Manufacture of cane sugar from sugarcane in India: Extraction of juice, Clarification, Concentration, crystallization, centrifugation, and other details of industrial process. Utilization of by-products of sugar industries. Testing and estimation of Analysis sugar by-I-Calorimetry II-Fehling solution.

Ref. 3: Chapter 38 Pg.1208 to 1218

Fermentation Industry: Introduction, importance, Basic requirements of fermentation process, Factors favouring fermentation, Fermentation operations. Manufacture of industrial alcohol from molasses, fruits, food grains, & ethylene, importance Power alcohol.

Ref.2: Pg. 578-596. Ref.3: Chapter 36, Pg. 1175-1190

Unit 5. Cement and Glass industry (08 L)

Cement industry: - Introduction, Definition and classification of cement, Importance, composition of Portland cement, Raw materials, proportioning of raw materials, Manufacture of Portland cement by using modern vertical shaft kiln/Rotary kiln, Uses of cement

Ref.7: Pg. 313-333 Ref. 8: Pg. 173-176, Ref. 10: Pg. 188-192

Glass industry Introduction, importance, Composition and structure of glass, physical and chemical properties of glass, chemical reaction, classification of glass, Outline of manufacture of Glass.

Ref.7: Pg.160-171; Ref. 8: Pg.247-265; Ref. 9: Pg. 197-212

Unit 6. Small Scale Industries (08 L)

Introduction and Aspects of Small-Scale Industries, Safety Matches, Agartbatties, Naphthalene balls, Wax Candles, Shoe Polishes, Gum Paste, Writing and fountain Pain ink, Plaster of Paris, Silicon Carbide Crucibles, how to Remove Stains and Liquid Phenyl Manufacturing.

Ref.5: - Chapter 60

Reference books

1. Principles of Industrial Chemistry, Chris A Clausen III and Guy Mattson, John Wiley and Sons, Inc. Somerset, 1978, New York.
2. Shreve's Chemical Process Industries, George T. Austin, 5 th Edition, The McGraw-Hill,
3. Industrial Chemistry by B. K. Sharma, 16th Edition, 2011
4. Comprehensive Industrial Chemistry, P.G. More, 1st Edition, Pragati Prakashan, Meerut,
5. Industrial Chemistry by B. K. Sharma, 16th Edition, 2011
6. Handbook of Industrial Chemistry Organic Chemicals, Mohammad Farhat Ali, Bassam M. El Ali, James G. Speight, The McGraw-Hill Companies, 2005, ISBN 0-07-141037-6
7. Industrial Chemistry-B.K. Sharma, Goyal publishing house, Meerut,
8. Shreve's chemical process industries 5th Edition, G.T. Oustin, McGraw Hill
9. Rigel's handbook of Industrial chemistry, 9th Edition, Jems A. Kent
10. Industrial chemistry –R.K. Das, 2nd Edition, 1976.

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OPTIONAL THEORY PAPER- Select ANY ONE of the following

CHEM 3506 (A): Nuclear Chemistry – I, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	TheAtomicNucleus,PropertiesofNucleonsandNuclei	08
2	Nuclear Models	12
3	Radioactivity	16
4	Nuclear Reactions	12

Learning objectives:

- The students are expected to know, the atom, elementary particles, sub-nucleons and the quarks, classification of nuclides, isotopes, isobars, isotones and isomers, Nuclear stability on the basis of even-odd nature of Z and N, N/Z ratio, the binding energy, the nucleus, its size and shape, mechanical effects due to orbiting and spinning of nucleons,magnetic quantum numbers, principal and radial quantum number.
- The students are expected to understand, the Shell model, magic number, salient features of shell model, nuclear configuration, the liquid drop model, semi-empirical mass equation.
- The students are expected to learn, types of radioactive decay, decay kinetics and their general characteristics, alpha decay, beta decay and gamma decay, nuclear isomerism, isomeric transitions, internal conversion, Auger effect.
- The students are expected to understand, Bethe's notation, different types of Nuclear reactions, conservation in nuclear reaction, excitation energy of compound nucleus.

Learning outcomes:

- Learning and knowing details aboutthe atom, elementary particles, sub-nucleons and the quarks, classification of nuclides, isotopes, isobars, isotones and isomers, factors affecting nuclear stability and quantum numbers.
- Understanding the Shell model,the liquid drop model and semi-empirical mass equation.

- Learning the types of radioactive decay, decay kinetics and their general characteristics,nuclear isomerism, isomeric transitions, internal conversion, Auger effect.
- Understanding theBethe's notation, types of nuclear reactions, conservation in nuclear reaction, compound nucleus theory.

Unit 1. TheAtomicNucleus,PropertiesofNucleonsandNuclei (08L)

Theatom,Elementaryparticles,Sub-nucleons,quarks,thenucleusandoutersphere,Classificationofnuclides,Nuclearstability,Even-oddnature,N/Zratio,TheNuclearpotential,Bindingenergy,Bindingenergycalculations. Thenucleus,itssize,shapeandradius,Mechanicaleffectsduetoorbitingandspinningofnucleons,Magneticquantum numbers, principalandradialquantumnumber.

Ref.1:Pg.1to13and 19to25.

Unit 2. NuclearModels (12L)

Historical, the shell model, Periodicity in nuclear properties: the magic numbers. The salientfeatures of shell model. The sequence of filling the orbit, Rectangular well potential model, Harmonicoscillatorpotentialmodel, Spin-orbit coupling model, Nuclearconfiguration of lighternuclides(Z <20),Meritsoftheshellmodel,Theliquiddropmodel,Thesemi-empiricalmassequation,Meritsofthe liquiddropmodel,Limitationsofliquiddropmodel.

Ref.1Pg. 64to69,72to84and91to92., Ref.2Pg. 464to469

Unit 3. Radioactivity(16L)

Discovery, Types of radioactive decay, Decay schemes, General characteristics of radioactivedecays,decaykinetics,unitsofradioactivity,problem solvingondecaykinetics.

Alpha decay: Alpha active nuclides, The alpha energy spectrum, Geiger-Nuttals law, The theoryofalphadecay.

Betadecay: Typesofbetadecay,absorptionandrangethroughmatter,Fermitheoryofbetadecay.(Mathematical detailsarenotexpected)

Gammadecay: Nuclearisomerismandisomerictransitions,internalconversion,Augereffect.

Ref.1Pg.100to106,120to135,138to142,and150to154.

Unit 4. NuclearReactions(12L)

Bethe's notation, Types of nuclearreactions, Conservationof nuclearreactions (Conservationofprotonsandneutrons,Conservationofmomentumandenergy),Reactioncross-section,Thecompoundnucleustheory,Calculationsofexcitationenergyofcompoundnucleus,Photonuclearreactions,Thermonuclearreactions.

Ref.1pages160to174and192to196.

References books

1. EssentialsofNuclearChemistrybyH.J.Arnikar,4th RevisedEdition,NewAge International Publishers.
2. SourcebookofAtomicenergybySamuelGlasstone,3rd edition,East-Westpress.

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CHEM 3506 (B): Polymer Chemistry – I, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	IntroductiontoPolymerChemistry	04
2	MechanismandNomenclatureofPolymers	04

3	ChemistryofPolymerization	10
4	PolymerizationTechniques	08
5	PolymerAdditives	06
6	MolecularWeightsofPolymers	05
7	SiliconeandCellulosePolymers	04
8	PolymerReactions	07

Learning objectives:

- The student needs to understand, History of polymers, Difference between simple compound and polymer, Names of polymers, Various methods of nomenclature, Difference between natural synthetic, organic and inorganic polymers.
- The students are expected to know, Terms-Monomer, Polymer, Polymerization, Degree of polymerization,Functionality, Number average, Weight average molecular weight, Mechanisms of polymerization, Polymerization techniques, Importance of silicone polymers.
- The students are expected to understand, Derivatives of cellulose polymers & their applications, Ingredients added to polymers, what are fillers?
- The students are expected to explain, Polymer reactions and their effect on physical and chemical properties,applications of polymer reactions, Advantages of polymer reactions to change their properties.

Learning outcomes:

- Understanding history, names and various methods of nomenclature of polymers, difference between (a) simple compound and polymer, (b) natural and synthetic polymers (c) organic and inorganic polymers.
- Knowing the terms -monomer, polymer, polymerization, degree of polymerization, functionality, number average, weight average molecular weight, mechanisms of polymerization, polymerization techniques, importance of silicone polymers.
- Understanding the cellulose polymers – derivatives and applications, Ingredients and fillers, Polymer reactions.

Unit 1. IntroductiontoPolymerChemistry (04L)

BriefHistory,Polymerdefinition,Preparation,Classification, Structures,Chemical bondingand MolecularforcesinPolymers.

Ref.1:Pg.1-14, Ref.2:Pg.1-16, Ref.3:Pg.1-12, Ref.4:Pg.1-17Ref.7:RelevantPages Ref.9:Pg.1-8

Unit 2. MechanismandNomenclatureofPolymers (04L)

PolymerizationMechanism,b)NomenclatureofPolymers-i)Common/Trivialnamesii)Source-Based names, iii) Structure-Based names (Non IUPAC), iv) IUPAC Structure-based and Linkage-basednomenclature system andv)Tradenames/Brandnames&Abbreviations

Ref.4:Pg.11-25, Ref.12:Pg.6-17

Unit 3. ChemistryofPolymerization (10L)

Introduction, b) Chain Polymerization: Free radical Polymerization, Ionic polymerization, Co-ordinationpolymerization-Ziegler-Nattacatalystc)StepPolymerization:Polycondensation, Polyadditionpolymerization,andRingOpeningpolymerization.

Ref.1:Pg.15-64, Ref.2:Pg.25-32,49-56,82-86,88-89,91-94, Ref. 3: Relevant Pages, Ref. 4: Relevant PagesRef. 6:Relevant Pages, Ref. 9:Pg.22-63

Unit 4. PolymerizationTechniques (08L)

Bulkpolymerization,Solutionpolymerization,Suspensionpolymerization,Emulsion polymerization,MeltPolycondensation,SolutionPolycondensation,Interfacialcondensation, electrochemicalpolymerization,Salientfeaturesofdifferentpolymerizationtechniques

Ref.1:Pg.71-79,82-84, Ref.2:Pg.126-132, Ref.4:Pg.309-324, Ref.12:Pg.335-341,173-175

Unit 5. PolymerAdditives **(06L)**

Fillers&Reinforcement,Plasticizers,Antioxidants&ThermalStabilizers(Heat Stabilizers), Ultraviolet stabilizers,Fireretardants,Colorants,Antistaticagents&Curingagents.

Ref.3:Pg.170-176, Ref.4:Pg.502-512,528-538, Ref.10:RelevantPages

Unit 6. MolecularWeightsofPolymers **(05L)**

(a) AverageMolecularweight,NumberAverage&WeightAverageMolecularweight,Molecular weight & degree of polymerization, Practical significance of polymer molecular weights,
(b) Molecular weight determination by End Group Analysis & Viscosity method and c) Problems based onNumberAverage&WeightAverage Molecularweight

Ref.1:Pg.86-89,92,96-98,402-409, Ref.2 & 4:RelevantPages

Unit 7. SiliconeandCellulosePolymers **(04L)**

(a) Introduction,Synthesis,Reactions,UsesofSiliconepolymers,
(b) Cellulose&Derivativesofcellulose:Rayon,Cellophane,Cellulose nitrate,Celluloseacetateandtheiruses.

Ref.1:Pg.255-261, Ref.5:Pg.143-155

Unit 8. PolymerReactions **(07L)**

Introduction,Hydrolysis,Hydrogenation,AdditionandSubstitutionreactions,Cross-linking reactions,Curereactions,Reactionsofvariousaliphaticandaromaticpendentgroupsinpolymers.

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

ReferenceBooks

1. PolymerSciencebyV.R.Gowarikar,N. V. Visvanathan,Jaydev Shreedhar, NewAge InternationalLtd.Publisher1996. (Reprint2012)
2. TextbookofPolymerSciencebyFredBillmeyer,3rdEdn.JohnWiley and SonsNewYork1984. (Reprint2008)
3. IntroductoryPolymerChemistrybyG. S. MisraNewAgeInternational(P)Ltd.Publisher1996.
4. PolymerChemistrybyCharlesE.Carraher(Jr.),6thEdn,(FirstIndianPrint2005),NewYork-Basel.
5. InorganicPolymersbyG. R. ChatwalHimalayaPublishingHouse1stEdn.1996
6. PolymerScience–ATextBookbyV.K.Ahluwalia,AnuradhaMishra.
7. PrincipleofPolymerSciencebyP.Bahadur,N.V.Sastry,2ndEdn,NarosaPublishingHouse.
8. PolymerChemistrybyAyodhyaSingh,2008,PublishedbyCampusBookInternational,New Delhi.
9. OrganicPolymerChemistrybyJagdambaSingh,R.C.Dubey,4thEdn,2012.
10. AdvancedPolymerChemistrybyV.K.Selvaraj,1stEdn,2008,PublishedbyCampu

sInternational,NewDelhi.
11. OrganicPolymerChemistrybyV.Jain,IVYPublishingHouse,NewDelhi.
12. PrinciplesofPolymerizationbyGeorgeOdian3rdEdn.JohnWiley&SonsNewYork.

CHEM 3506 (C): IntroductiontoBiochemistry&MolecularBiology– I
(03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	AminoacidsandProteins	11
2	Carbohydrates	06
3	Lipids	06
4	Hormones	03
5	Enzymes	07
6	VitaminsandCoenzymes	04
7	CellBiochemistry	05
8	Biochemicaltechniques	06

Learning objectives:

- The student needs to understand of Cell types, Difference between a bacterial cell., plant cell and animal cell. Biological composition and organization of cell membrane as perSinger and Nicholson model, structure and function of various cell organelles of plant and animalcell. Concepts of biomolecules, Bonds that link monomeric units to form macromolecules.
- The student needs to know the types of carbohydrates and their biochemical significance in living organisms, structure of carbohydrates and reactions of carbohydrates withGlucose as example. Properties of carbohydrates.
- The student needs to learn the types of lipids with examples, structure of lipids, propertiesof lipids.
- The student needs to know the structure and types of amino acids, Reactions of amino acids. Properties of amino acids. Peptide bond formation. Types ofproteins. Structural hierarchy in proteins. Features of denaturation of proteins.
- The student needs to understand the classes of enzymes with subclasses and examples, Enzyme specificity, Equations of enzyme kinetics Km and its significance, features of various types ofenzyme inhibitions.
- The student needs to learn the principle, working procedure andapplications of various techniques used in biochemical studies.
- The student needs to know the types of vitamins,source,biochemical significance and deficiency disorders. Coenzyme forms of Vitamin B complex and their metabolic significance.
- The student needs to understand, Basic concepts of Endocrinology. Types of Endocrine glands and their hormones. Biochemical nature of hormones. Role of Second messengers in hormone action.

Learning outcomes:

- Understanding the cell types- bacterial cell., plant cell and animal cell. Biological composition and organization of cell membrane, Singer and Nicholson model.Biomolecules and macromolecules.
- Knowing the carbohydrates and their biochemicalsignificance, structure, properties and reactions of carbohydrates with glucose as example.
- Learning the details about, lipids, amino acids, proteins, enzymes and vitamins.
- Understanding the details in biochemical studies, basic concepts of Endocrinology. Endocrine glands and their hormones.

Unit 1. Aminoacidsandproteins:(11L)

Introduction,biologicalfunctions,classification-basedonstructure,functionandcomposition.Structural organization of proteins- primary, secondary, tertiary and quaternary structures (generaloverview).Factorsthat stabilizeproteinstructure. DenaturationofProteins.

Ref:3,Chapter4, (Pg.45-71)

1) Foldingsandmisfoldingsofproteinsbystepwise process
2)Diseasescausedbymisfoldingsofproteinsforex. Alzheimer, Prions

Ref:1,Pg.116to153

Unit 2. Carbohydrates:(06L)

Introductionofcarbohydrates,Introductionandbiologicalsignificanceofproteoglycans,Glycoproteins,Glycolipids,LectinCarbohydrates-Interaction (Sugarcode).Analysisofcarbohydrates.

Ref.1:Pg. 255to268, Ref.2:Pg.648to653.

Unit 3 Lipids:(06L)

Introduction,Biologicalsignificance,Classification- Simple, compound,steroidsandderivedlipids.Structureofsaturatedandunsaturatedfattyacids,structureofphospholipids(Phosphatidicacid,Lecithin, Cephalin, Lipositol), structure of Sphingomyelin and Cholesterol. Amphipathic lipids and theirbehaviorinwater. saponificationnumber,Acidnumber,Iodinenumberandtheirsignificance. Rancidityoflipids.TypesofLipoproteinsandtheirsignificance,StructuralLipidsinmembraneglycerophopholipids,Sulphalipids,Galactolipids,glycosphingolipids

Ref.1:Pg. 343to360, Ref:3,Ch.3,Lipids,Pg.29-42.

Unit 4. Hormones:(03L)

Definition, classification based on biochemical nature, location and mechanism of action. Concept ofsecondmessengers-c. AMPandCalciuminositide system.

Ref:2,Ch.42and43,Pg.434,462and464.

Unit 5. Enzymes:(07L)

Classification-Sixmajorclassesofenzymes,Conjugatedenzymes-Apo enzyme,Holoenzyme,prostheticgroup(coenzymesandcofactors).Featuresofactivesite. enzymespecificity,Factorsaffectingenzymeactivity-substrateconcentration,pH,temperature,andenzymeconcentration,product concentration. MM equation, LB equation (derivation not required) and significance of Km.Enzyme inhibition-competitive, noncompetitive and uncompetitive with suitable examples. Allostericenzymes andclinicalsignificanceofIsoenzymes.

Ref:3,Ch.6,Enzymes,Pg. 85–112.

Unit 6. VitaminsandCoenzymes:(04L)

Classification-Fatsolubleandwatersolublevitamins(source,biologicalfunctionsanddeficiencydisorders), coenzymeformsofvitaminBcomplex. (Structure notrequired).

Ref:2,Ch.45:Pg. 481-496

Unit 7. CellBiochemistry:(05L)

IntroductiontoCell,UnicellularandMulticellularorganisms,DistinguishingfeaturesofProkaryoticand Eukaryotic cell. Structure and function of Cell membrane, Mitochondria, Endoplasmic reticulum,Golgi complex, Lysosomes,Peroxisomes, Plant cell walland Chloroplast.Concepts ofBiomoleculesand typesofbondsinbiomolecules.

Ref:5,Ch.3,Pg. 32-68, Ch.10, Pg. 191-219,Ch.6,Pg. 154-165,

Ch.7,Pg. 166- 174,Ch.8,Pg. 175-183,Ch.9,Pg. 184-189, Ch.1,Pg. 220-240.

Unit 8. Biochemicaltechniques.(06L)

Principle, working and applicationsof dialysis, Paper chromatography, Thin layer chromatography,Columnchromatography-
Gelfiltration,Ionexchange,AffinityChromatography.Electrophoresis-
PaperandGel(Agarose,NativeandSDS-PAGE).

Ref:6,Ch.11,Pg. 524-546.Ch.10,Pg. 449-473.2,Ch.3,Pg. 89-97,Pg. 344-421,

ReferenceBooks

1. Lehninger's,PrinciplesofBiochemistry,byNelsonandCoxMacmillanPublisher4th edn.
2. Harper'sIllustratedBiochemistry,26thEdition.
3. BiochemistrybyU.Satya Narayana
4. Biotechnology,B. D. Singh,3rdedition.
5. Cellbiology,Genetics,MolecularBiology,EvolutionandEcology,byVermaandAgarwal,14thedition.
6. PrincipletechniquesofBiochemistryandMolecularBiologybyKeithWilsonandJohnWalker,6thedition.
7. BiophysicaltechniquesbyUpadhyayandNath,3rdrevisededition.

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CHEM 3506 (D): EnvironmentalandGreenChemistry– I, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	ConceptsandscopeofEnvironmentalChemistry	02
2	AtmosphereandAirPollution	14
3	Hydrosphereandwaterpollution	08
4	IntroductiontoGreenChemistry	10
5	GreenChemistryandTechnologyforsustainabledevelopment	10
6	GreenChemistryandHazardousOrganicSolvents	04

Learning objectives:

- The student should have expected to know, Importance and conservation of environment, Segments of atmosphere, Hazards of flue gases, Ozone depletion, Ecological changes due to hazardous gases, the social issues.
- The student needs to understand, Water resources, Quality of potable water, WHO limits for toxic materials in water stream, Quality measures.
- The student needs to learn, need of green chemistry technology, Principles of green chemistry, Advantages of green chemistry, Simple examples to clarify the principles, Catalytic routes for sustainable developments.

Learning outcomes:

- Knowing the importance and conservation of environment, atmosphere, Hazards of flue gases, Ozone depletion, Ecological changes and related social issues.
- Understanding the water resources, potable water, WHO limits, Quality measures.
  Learning the details of green chemistry technologyfor sustainable developments

Unit 1:ConceptsandScopeofEnvironmentalChemistry(02 L)

Introduction, Terminologies, Unitsofconcentration, SegmentsofEnvironment

Ref.1,Ref.3

Unit 2:AtmosphereandAirPollution(14 L)

Compositionandstructureofatmosphere, Chemicalandphotochemicalreactionsinatmosphere ChemistryofO3,SOx,NOxandchloridesinatmosphere, Primaryairpollutants, Samplingofair Particulatematter:inorganicandorganic, Smog:reducingandphotochemical, Mechanismofozone Depletion, StabilityandreactionsofCFCs, HarmfuleffectsofCFCs, CFCssubstitutes Bhopalgastragedy

Ref.1,Ref.3,Ref.5

Unit 3:HydrosphereandWaterpollution (08 L)

Waterresources, Physicalchemistryofseawater:composition,equilibria,pH,pE Microbiallymediatedaquaticreactions,nitrogencycle,ironandmanganesebacteria Classificationofwaterpollutants, OrganicandInorganicpollutants:Pesticides,Detergents, Eutrophication,Marine,Oil,Acidmine drainage,remedial measuresandsediments, Thermal Pollution, Samplingandmonitoringwaterqualityparameters:pH,D.O.(WinklerMethod), COD,TOC,Totalhardness,freechlorine.

Ref.1,2,3,and5

Unit 4.IntroductiontoGreenChemistry(10 L)

Chemistryisgood, Theenvironmentandthefiveenvironmentalspheres WhatisenvironmentalChemistry? EnvironmentalPollution, whatisgreenChemistry? GreenChemistryandsyntheticchemistry, Reductionofrisk:Hazardandexposure Theriskandnorisks, Wasteprevention, Basicprinciplesofgreenchemistry Examplesbasedongreentechnology.

[Ref:GreenChemistrybyStanleyEManahan,ChemcharResearchInc.(2006)-2nd Edn. Ch.1,Pg. 1-17andRef.6Relevantpages.]

Unit 5.GreenChemistryandTechnologyforsustainabledevelopment(10 L)

GreenChemistryfromtheorytopractice, Thetwelveprinciplesofgreenchemistry GreenChemistryandsustainableDevelopment, DesigningProductsundertheholisticapproach" Cardle-toCardle", Scientificareasforpracticalapplicationsofgreenchemistry Useofalternativebasicchemicalsasfeedstockinchemicalindustryandresearch. GreenChemistryandReductionofsolventToxicity(AlternativeSolventsorreplacement) ApplicationsofNewMethodologiesinthesynthesisofchemicalcompounds-catalysisandgreen chemistry.

[Ref:GreenChemistry–GreenengineeringbyAthanasios ValavanidisandThomais Vlachogianni (March 2012);Ch.2Pg. 17-37 and Ref.6 Relevantpages]

Unit 6.GreenChemistryandHazardousOrganicSolvents (Greensolvents,replacementandalternativetechniques). (04 L)

IntroductiontoGreenChemistryandToxicorganicsolvents GreensolventsandAlternativemethods GreenChemistry,Greensolvents–Alternativetechniquesinorganicsynthesis [Ref:GreenChemistry–Greenengineering,Chapter5,Pg. 81-91,Ref.6Relevantpages]

ReferenceBooks

1:EnvironmentalChemistry–A.K.De,5thEdition(Newageinternationalpublishers)
2:EnvironmentalChemistry–J.W.MooreandE.A.Moore(AcademicPress,NewYork)
3:EnvironmentalChemistry–A.K.BhagiandC.R.Chatwal(HimalayaPublishingHouse)
4:AnalyticalChemistry–G.D.Christian4thEdition(JohnWileyandSons)
5:EnvironmentalChemistry–H.Kaur2ndEdition2007,Pragati Prakashan,Meerut,India

6.EnvironmentalChemistrywithGreenChemistryA.KDas,BooksandAllied(P)Ltd,

CHEM 3506 (E): AgricultureChemistry, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	1.SoilChemistry	10
2	2.ProblematicSoilandSoiltesting	10
3	3.QualityofIrrigationWater	08
4	4.PlantNutrients	08
5	5.FertilizersandManures	06
6	6.ProtectionofPlants	06

Learning objectives:

- The student needs to understand,the role of agriculture chemistry and its potential, basic concept of soil, properties of soil & its classification on the basis of pH
- The student needs to know the different plant nutrients, their functions and deficiency symptoms, importance of manures as compared to chemical fertilizers, the importance of green manuring, various techniques to protect the plants.
- The student needs to have the knowledge of various pesticides, insecticides, fungicides and herbicides and able to identify the problematic soil and recommend method for their reclamation.
- The student needs to know, quality irrigation water, water quality standards and analysis ofirrigation water.

Learning outcomes:

- Understanding the role of agriculture chemistry and its potential, basic concept, properties &classification of soil on the basis of pH
- Knowing the details of plant nutrients, importance of manures, green manuring, various techniques to protect the plants.
- Learning about pesticides, insecticides, fungicides and herbicides,problematic soil and reclamation. Knowing details about irrigation water, water quality standards and analysis.

Unit 1. SoilChemistry (10L)

Roleofagriculturechemistry, Scopeandimportanceofagriculturalchemistry, Agricultural chemistryandotherscience, Definitionofsoil,Soilcomponents-mineralcomponent,organicmatter orhumus,soilatmosphere,soilwater,soilmicroorganism, Physicalpropertiesofsoil-soiltexture, soilstructure,soilcolor,soiltemp,Soildensity,porosityofsoil, Surfacesoilandsub-soil, Chemicalpropertiesofsoil,soilreactionsandsolutions, Factorcontrollingsoilreaction, bufferingcapacity,importanceofbufferactioninagriculture,ionexchange

Ref1-Pg.8-12,92-94,98-113,116-146, Ref3-Pg.28-50

Unit 2.ProblematicSoilandSoiltesting (10L)

Acid soil – formation of acid soil, effect of soil acidity, reclamation of it. AlkaliSoil-formationofalkalisoil,reclamationofalkalisoil, Classificationofalkalisoil-salinesoil,salinealkalisoil,non-salinealkalisoil, Calcareoussoils

Introductiontosoiltesting, Objectivesofsoiltesting
Phasesofsoiltesting-collectionofsoilsample,analysisinthelaboratoryand
fertilizerapplications.

Ref1, Pg. 345-370,Ref3, Pg. 301-312,Ref4, Pg. 135-147and150-159

Unit 3. QualityofIrrigationWater(08L)

SourcesofWater-Atmosphericwater,SurfaceWater,StoredWater,GroundWater
ImpuritiesinWater,Waterquality,relatedproblemsinpublichealth,environment and
agriculture, Analysisofirrigationwater(ppm,meq /lit.epm), Dissolvedconstituentsandtheir
function, Majorconstituents-Ca,Mg,Na,K,Carbonate,bicarbonate,sulfate,Chlorideandnitrate
Minorconstituents-B,Si,nitrite,Sulfideandfluoride, Waterqualitystandard-totalsolublesalt
(TSS),sodiumadsorptionratio(SAR),Exchangeablesodiumpercentage(ESP),Residualsodium
carbonate,salinityclassesforirrigationwater

Ref8-Pg. 293-309

Unit 4. PlantNutrients **(08L)**

Needofplantnutrients,formsofnutrientsupdates,nutrientabsorptionbyplants
Classificationofessentialnutrients
Primarynutrients(N,P,K),itsroleanddeficiencysymptomsinplants
Secondarynutrients,(Ca,Mg,S),itsroleanddeficiencysymptomsinplants
Micronutrients,Generalfunctionsofmicronutrients(Zn,Fe,Mn,Cu,B,Mo,Cl)
Effectofenvironmentalcondition,nutrientuptake

Ref3-Pg. 207-241,Ref4-Pg. 176-195,Ref7-Pg. 287-300

Unit 5. FertilizersandManures(06 L)

Fertilizers

Introduction,Classification&applicationoffertilizers, Timeandmethodsoffertilizers
Factorsaffectingefficiencyoffertilizers,
Vermicompostpreparation,effectofvermicompostonsoilfertility
Syntheticfertilizersdefinition,comparisonofsyntheticfertilizerswithorganicfertilizers,
environmentaleffectofsyntheticfertilizers

Manures

Introduction,Definitionandclassificationofmanures, Effectofbulkyorganicmanuresonsoil,
farmyardmanures(FYM),FactorsaffectingonFYM,methodofpreparation,lossesduringhandling
andstorage, Biogasplant.Humanwaste,sewageandsludge,typesofsludge,carbonnitrogenratio,
sewage irrigationanduses, Greenmanuring,typesofgreenmanuring,characteristics,advantages
anddisadvantages ofgreenmanuring, Biofertlizers:definition,classification,role&advantages

Ref2-Pg.205-213,Ref3- Pg. 90-112,137-149

Unit 6. ProtectionofPlants **(06L)**

PesticideClassificationandmodeofaction
Insecticide-Definition,Classification,chemicalproperties,elementalcomposition,modeofactionof
syntheticandplantoriginatedcompoundsorganophosphates,malathion,parathion, carbamates
Fungicides-Definition,Classification,Chemicalproperties,modeofactionofS &Cufungicides
Herbicides-Definition,Classification,composition,modeofactionofSelectiveandnon-selective

herbicides

Ref6-RelevantPages

ReferenceBooks

1. AtextbookofsoilscienceRevisedEdnJ.A.Daji,
RevisedbyJ.R.Adam, N.D.Patil,Mediapromotersandpublishers,Mumbai, 1996
2. TextbookofsoilscienceT.D.Biswas,S.K.Mukherjee,TataMcGrawHill
Publishingcompany,NewDelhi
3. IntroductiontoAgronomyandsoil,watermanagement,V.G.Vaidya,K.R.
Sahashtra Buddhe(Continental Prakashan)
4. PrincipalsofsoilscienceM.M.Rai,MilliancomplexofIndia,Bombay,1977
5. Manuresandfertilizers(sixthedn),K.S.Yawalkar,J.P.AgarwalandBokde,
Agrihorticulture publishing house,Nagpur,India
6. Chemistryofinsecticidesandfungicides,U.S.Sreeramula(2ndEd),oxford
andIBHPublishing company,NewDelhi
7.FundamentalsofsoilsciencesC.E.MillarandL.M.Turk,Bio-Tech-NewDelhi(1stEd2001)
8. Soil,Plant,Waterandfertilizeranalysis,P.K.Gupta,PublishedbyAgroBotanica
9. **Biofertlizers**andbio pesticides,Author:Deshmukh,A.M.

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CHEM 3506 (F): Synthesisofnanomaterial and Nano toxicology
(03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	Synthesisofnanomaterial(ChemicalMethods)	09
2	Synthesisofnanomaterial(ChemicalMethods)	09
3	Synthesisofnanomaterial(ChemicalMethods)	09
4	Synthesisofnanomaterial(BiologicalMethods)	09
5	IntroductiontoNanotoxicology	12

Learning objectives:

- The student needs to learn and understand details about the different chemical and biological methods for synthesis of nanomaterials.
- The student needs to know the assessment of the toxicological properties of nanoparticles (NPs) and adverse effects of nanomaterials on organisms and ecosystems.
- The student needs to understand the production, use, safety and disposal of nano-structured materials like nanoparticles, nanomedicines.
- The student needs to become familiar with interactions of engineered nanomaterials with biological systems and the environment and correlation between the physicochemical properties of nanomaterials with induction of toxic or adversarial biological responses.

Learning outcomes:

- Knowing and understanding the process of synthesis of nanomaterials using different chemical pathways.
- Learning the use of microorganisms,plantextract,proteins,and DNA in biological synthesis of nanomaterials.
- Understanding the toxicological properties of nanoparticles onbiological systems and the environment.

Unit 1:Synthesisofnanomaterial(ChemicalMethods) (09 L)

Colloids andcolloidsinsolution,Nucleationandgrowthofnanoparticles,Synthesisof metalandsemiconductornanoparticlebycolloidalroutes,Langmuis-Blodgett(L-B) method,sol-gelmethod.

Unit 2:Synthesisofnanomaterial(ChemicalMethods) (09 L)

Hydrothermal synthesis, Solvothermal synthesis, Sonochemical Synthesis, Microwavesynthesis, Synthesisusingmicro-reactororLab-or-chipspraypyrolysis, successiveionic layeradsorption andreaction (SILAR),Electrodeposition,

Unit 3:Synthesisofnanomaterial(ChemicalMethods) (09 L)

Chemical vapour deposition, Metalorganic chemical vapour deposition (MOCVD), Plasma enhanced chemical vapour deposition (PECVD), Vapour-Liquid-Solid (ULS)method, MetalOxideframework (MoF), Kirkindalleffectandmethod.

Unit 4:Synthesisofnanomaterial(BiologicalMethods) (09 L)

Introduction,Synthesisusingmicroorganisms,Synthesisusingplantextract,Use of proteins,TemplateslikeDNA,S-tayersynthesisof nanoparticlesusingDNA.

Unit5:IntroductiontoNanotoxicology (12 L)

Physicochemicaldeterminants: SizeShape, SurfaceareaSurfacechemistry Material composition, Redoxcycling and catalytic chemistry, UV activation leading to radical formation,Surfacecoatings for protection, passivation, hydrophobicity,hydrophilicity, Effect of material synthesis methods, solvents etc. NPsDegradation.

Routesof Exposure:oralrespiratorytract,Skin,Gastrointestinaltract,injection Risksevaluationboth*invitro*and*invivo*studies,*Invivo*abnormalbehavior,clinicalsigns,mortality, bodyweightchanges, histological observation Histopathology, Immunohistochemistry, SEM, TEM, AFMSpectroscopictechniques: AAS, X-rayfluorescence, SEM-EDS

ReferenceBooks

1. Nanotechnology: TechnologyRevolutionof21st CenturybyRakeshRathi,publishedbyS. Chand.
2. IntroductiontoNanoscience,byStuartLindsay.
3. IntroductiontoNanomaterialsandnanotechnologybyVladimir Pokropivny,Rynno Lohmus,IrinaHussainova,AlexPokropivnyandSergeyVlassov
4. NanomaterialsbyA.K.Bandyopadhyay;NewAgeInternationalPublishers.
5. NanotechnologybyMarkRatnerandDanielRatner,PearsonEducation.
6. NanoEssentials-T. Pradeep / TMH
7. Bharat Bhusan, "Springer Handbook of Nanotechnology", Springer,New York,2007
8. Nanotechnology:Principles&Practices.Sulbha K. Kulkarni,Capital Pub(3rd Edition)
9. Nanostructures and Nanomaterials Synthesis, Properties and Applications, Guozhong Cao,imperialscollegePress,London.

10. Nanomaterials: Synthesis, properties and Applications. Edited by A. S. Edelstein & R. C.Commutate, Instituteof Physics Publishing, Bristol&Philadelphia.
11. NanomaterialsbyA.K.Bandyopadhyay(2nd Edition),International Publishers.

CHEM 3507: Physical Chemistry Practical – I, (02 Credits, 10 Practicals)

(Any **TEN Experiments** from the given List of Experiments)

Learning Objectives:

- To develop skills required in Physical chemistry experiments such as the appropriate handling of apparatus, instruments and preparation stock / standard solutions.
- The student will learn the skills needed foroperation and safe conduct of instruments and interpretation of chemical data.
- To familiar the students with an adequate extent of experimental techniques with hands on training using modern instrumental methods of chemical analysis.
- The student will obtain the ability to interpret and communicate scientific information effectively in written and oral formats.

Learning Outcomes:

- Understanding the principle, theory, preparation of required chemicals, procedure, experimental methodology, calculations and interpretations in quantitative instrumental and non-instrumental analysis.
- Developing the experimental and operational skill with hands on training using sophisticated instruments and practicing for mathematical and graphical interpretation

Group – A: Non Instrumental Experiments (ANY FIVE)

1. To study the effect of addition of salt on critical solution temperature of phenol- water System.
2. To determine the molecular weight of a high polymer by using solutions of different concentrations.
3. To determine the order of reaction between $K_2S_2O_8$ and KI by half-life method.
4. Determine the rate constant of reaction between potassium persulphate and potassium iodide for equal concentration of the reactants (a=b).
5. To compare the relative strength of HCl and H_2SO_4 by studying the kinetics of hydrolysis of an ester.
6. To compare the relative strength of HCl and H_2SO_4 by studying the kinetics of Inversion of cane sugar using Polarimeter.
7. To compare the precipitation value of sodium chloride, barium chloride and aluminum chloride for arsenious sulphide sol.
8. To compare the effectiveness of a number of emulsifying agents in forming emulsions.

Group – B: Instrumental Experiments (ANY FIVE)

1. 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 by conductometry.
2. To estimate the amount of lead present in given solution of lead nitrate by Conductometric titration with sodium sulphate.
3. To determine the degree of hydrolysis of aniline hydrochloride by pH metry.

4. To determine pKa value of given weak acid by pH-metric titration with strong base.
5. To prepare standard 0.2 M Na_2HPO_4 and 0.1 M Citric acid solution, hence prepare four different buffer solutions using them. Determine the pKa value of thus prepared and unknown buffer solutions using potentiometry.
6. To determine the concentrations of strong acid and weak acid present in the mixture by titrating with strong base using potentiometry.
7. Determination of λmax and concentration of unknown solution of $KMnO_4$ in 2 N H_2SO_4.
8. Determination of λmax and concentration of unknown solution of $CuSO_4$.
9. To determine the molecular refractivity of the given liquids A, B, C and D.
10. To determine the molar refraction of homologues methyl, ethyl and propyl alcohol and show the constancy in contribution to the molar refraction by - CH_2 group.

Reference books:

1. Practical Physical Chemistry, 3rd ed. A. M. James and F. E. Prichard, Longman publication.
2. Experiments in Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.
3. Advanced Practical Physical Chemistry, J. B. Yadav, Goal 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.
6. Comprehensive experimental Chemistry, V. K. Ahluwalia and S. Raghav, New Age International
7. Senior Practical Physical Chemistry, Khosla, B. D.; Garg, V. C. & Gulati, A. R. Chand & Co.
8. Experiments in Physical Chemistry, Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. 8th ed.; McGraw-Hill: New York (2003).
9. Experimental Physical Chemistry Halpern, A. M. & McBane, G. C. 3rd ed.; W.H. Freeman & Co.: New York (2003).
10. Experimental Physical Chemistry, Athawale V. D. and Mathur P., New Age International (2001)

Que. No.	Experiment	Max. Marks
1	One Experiment from Group – A	25
2	One Experiment from Group - B	25
3	Oral	10
	Total Marks	**60**

Structure of Practical Examination

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CHEM 3508: Inorganic Chemistry Practical – I, (02 Credits, 10 Practicals)

(Any **TEN Experiments** from the given list of Experiments)

Learning Objectives:

- To familiar the students with safe working methods and safety standards required in handling laboratory chemicals, strong oxidizing and reducing agents and hazardous chemicals.

- To develop skills required in Inorganic chemistry practicals such as the preparation stock / standard solutions, appropriate methods for gravimetric and colorimetric estimations, smooth handling and use of instrument like flame photometer.
- The student will learn the skills needed for performing the inorganic preparations, various steps involved and able to calculate practical yield.

Learning Outcomes:

- Knowing the safe working methods and safety standards in laboratory.
- Undertakingthe correct route in inorganic preparations, gravimetric and colorimetric estimations and flame photometric determinations.

A) Gravimetric estimations (ANY THREE)

1. Iron as Fe_2O_3
2. Nickel as Ni – DMG
3. Chromium as $PbCrO_4$
4. Barium as BaSO4 using homogeneous precipitation method.

B) Inorganic Preparation (ANY FOUR)

1. Preparation of Potassium Tri-oxalato ferrate (III), $K_3[Fe(C_2O_4)_3]$.
2. Preparation of tris (acetyl acetanato) Chromium(III) $[Cr(acac)_3]$.
3. Preparation of Tri-chlorotriammine cobalt (III) $[Co(NH_3)_3Cl_3]$
4. Preparation of tris (di-pyridyl) Manganese (III) chloride
5. Preparation of Tris(Thiourea) Copper (I) Chloride [Cu $(Thiourea)_3$] Cl.
6. Preparation of Manganese (III) acetylacetonate $[Mn(acac)_3]$.

C) Colorimetric Estimations (ANY ONE)

1. Iron by 8 HQ method.
2. Titanium by H_2O_2.
3. Nephelometric estimation of Ca / Ag / Na / Ba by precipitation method

KF Vs. $CaCl_2$	$AgNO_3$ Vs. KBr,
Na_2SO_4 Vs. $BaCl_2$	NaCl Vs $AgNO_3$

D) Flame Photometry

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

Reference Books

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

Structure of Practical Examination

Que. No.	Experiment	Max. Marks
1	Q. 1. Gravimetric experiment	35
2	Q. 2. (Any **ONE** of the following) • Inorganic Preparation • Flame Photometry • Colorimetric Estimation	15
3	Q. 3. Oral	10
	Total Marks	**60**

CHEM 3509: Organic Chemistry Practical – I, (02 Credits, 10 Practicals)

Learning Objectives:

- To develop skills required in Organic chemistry practicals such as the appropriate handling of apparatus and chemicals.
- The student will learn the laboratory skills and experimental techniques needed to design, safe conduct, and successful completion of chemical synthesis.
- To expose the students to an appropriate characterization and conformation methods using modern instrumentation.
- The student will acquire and develop the ability towards effective communicationof scientific information and interpretation of obtained results in written and oral formats.

Learning Outcomes:

- Separating and analyzing the water-soluble and water- insoluble binary mixture.
- Estimating - Acetamide, Glucose and Glycine by volumetric method.
- Estimating basicity of various acids.
- UnderstandingTLCand purification techniques used in organic synthesis.

A) Separation of Binary Mixtures and Qualitative Analysis (ANY FOUR MIXTURES)

Solid-Solid (2 Mixtures), Solid-Liquid (1 Mixture), Liquid-Liquid (1 Mixture).
At least one mixture from each of the following should be given -
(Acid-Base, Acid-Phenol, Acid-Neutral, Phenol-Base, Phenol-Neutral, Base-Neutral, 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 (ANY TWO)

1. Estimation of acetamide.
2. Determination of Molecular weight of monobasic acids by volumetric methods.
3. Estimation of basicity (Number of -COOH groups) of acid.
4. Saponification value of oil.

C) Organic Preparations (ANY FOUR)

1. Adipic acid from cyclohexanone (Oxidation by Con. HNO_3).
2. Benzoquinone from Hydroquinone (Oxidation by $KBrO_3/K_2CrO_3$).

3. P-nitro acetanilide from Acetanilide (Nitration).
4. β-Naphthyl ether from β-naphthol (Methylation by DMS, NaOH).
5. Hippuric acid from Glycine (Benzoylation).
6. p-Iodo nitrobenzene from p-Nitro aniline (Sandmeyer Reaction).
7. Benzil- Benzilic acid rearrangement reaction.

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. Vogel.
2. Practical Organic Chemistry by – O.P. Agarwal.

Structure of Practical Examination

Que. No.	Experiment	Max. Marks
1	Separation of Binary Mixture and qualitative Analysis	30
2	Organic Estimation/ Preparation	20
3	Oral	10
Total		**60**

Semester VI

CHEM 3601: Physical Chemistry –II, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	Electrochemistry	14
2	Nuclear Chemistry	12
3	Surface Chemistry	08
4	Catalysis	06
5	Quantum Chemistry	08

Unit 1: Electrochemistry (14 L)

Reversible and irreversible cells, EMF and its measurements, standard cells, cell reaction and EMF, single electrode potential and its calculation, calculation of cell EMF, thermodynamics of cell EMF, types of electrodes, classification of electrochemical cells with and without transference, Capacitors, Types of batteries, applications of EMF measurement, such as (a) Solubility product of sparingly soluble salt, (b) Determination of pH, (c) Potentiometric titration; Numericals.

Unit 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, Numericals.

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 patient's body, Goitre

Unit 3: Surface Chemistry (08 L)

Adsorption phenomenon, Adsorption of gases by solids, Types of adsorption, Freundlich, Langmuir and Temkin isotherms, Adsorption of solute by solids, Types of adsorptions (Physical & Chemisorption). BET equation (no derivation), determination of surface area using Langmuir and BET equations, Numericals.

Unit 4: Catalysis (06 L)

Catalysis, types of catalysis, homogeneous and heterogeneous catalysis, Characteristics of catalytic reactions, promoters, catalytic poisoning, Autocatalysis, positive and negative catalysis, activation energy and catalysis, theories of catalysis, acid-base catalysis, enzyme catalysis and its mechanism.

Unit 5: Quantum Chemistry (08 L)

Postulates of quantum theory (wave function and its interpretation, well-behaved function, quantum mechanical operators, eigen values and eigen functions, expectation values) formulation of Schrodinger equation, particle in box (1D, 2D and 3D box, No derivations for 2D and 3D box), sketching of wave function and probability densities for 1D box, correspondence principle, degeneracy (lifting of degeneracy, Jahn-Teller distortion), applications to conjugated systems such as butadiene, hexatriene and β-carotene; harmonic oscillator, zero point energy and quantum tunnelling, Numericals.

Reference books

1. Principles of Physical Chemistry, S.H. Marron and C.F. Prutton, 4 th edn
2. Essentials of Physical Chemistry, B. S. Bahl, G.D. Tuli and Arun Bahl, 2000 edn, S Chand.
3. Essentials of Physical Chemistry, Bahl, -Tuli- Revised multicolor edn 2009.
4. Quantum Chemistry, Manas Chandra, second edn.
5. Physical Chemistry- a molecular approach, Donald A. McQuarrie, John D. Simon.
6. Essentials of Nuclear Chemistry, Prof. H.J. Arnikar Fourth edn.
7. Nuclear and Radiochemistry, Friedlander and Kennedy.

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CHEM 3602 Inorganic Chemistry –II, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	Chemistry of f-block element	08
2	Metals Semiconductors and Superconductors	10
3	Ionic Solids	06
4	Homogeneous Catalysis	08
5	Heterogeneous Catalysis	10
6	Bioinorganic Chemistry	08

Unit 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

A) 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

B) 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 Pg. 859-863, 865-866, 874 – 875, 879-886, 891-893, 898-900

Unit 2: Metals, Semiconductors and Superconductors (10 L)

Introduction, Metallic bonding, Band theory in metals with respect to Na along with n € and N€ 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 semi conductivity, N type semiconductors ZnO and NiO, Super conductivity- Discovery, Property, Models structure and superconductivity, Applications of superconductors,

Ref. 6, Ref. 7 Pg. 209-221,

Unit 3: Ionic Solids (06 L)

Crystalline and amorphous solids, crystal structures simple cubic, body centred cubic and face entered 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 Pg. 32-61, Ref. 5 Pg. 102-127, Ref. 7 Pg. 55-62

Unit 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, Ref. 6, Ref. 13 Pg. 650 - 652 and 656 - 661

Unit 5: Heterogeneous Catalysis (10 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 KMnO4
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- i. Benzimidazole synthesis using o-phenenediamine and benzaldehyde by acidic support or clay-solid support, amber list or NH4Cl.
D. Biodiesel Synthesis- using heteropoly acid catalyst-
Transesterification using phosphomolybdic or phosphotungstic acid.

Ref. 5, Ref. 11, Ref. 13

Unit 6: Bioinorganic Chemistry (08 L)

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).
d. Metalloproteinase-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-B12, its structure and function.

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

Reference Books

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

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CHEM 3603 Organic Chemistry – II, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	Reactions of unsaturated Hydrocarbons and Carbon –oxygen double bond	10
2	Retrosynthetic Analysis and Applications	04
3	Rearrangement Reactions	06
4	Spectroscopic Methods in Structure Determination of Organic Compounds	22
5	Natural Products	06

Unit 1: Reactions of unsaturated Hydrocarbons and Carbon –oxygen double bond.

(10 L)

a) Reactions of Carbon-Carbon double bond:

Introduction, Mechanism of electrophilic addition to C=C bond, Orientation and reactivity, Rearrangement, Mechanism of addition of hydro halogen, Anti-markownikoff's addition, addition of halogen, addition of hypohalous acid, hydroxylation, hydroboration-oxidation, hydrogenation and ozonolysis.

Ref. 1: Pg. 317-323, 327-343, 346-355 and 357-360.

b) **Reactions of Carbon-Carbon triple bond**:

Mechanism of addition of hydrogen, Halogen acids, Water. Formation of metal acetylides and its applications.

Ref. 1: Pg. 431-433.

c) **Reactions of Carbon-Oxygen double bond**:

Introduction, Structure of carbonyl group, Reactivity of carbonyl group, Addition of hydrogen cyanide, alcohol, thiols, water and Reformatsky reactions with mechanism.

Ref. 1: Relevant pages.

Unit 2: Retrosynthetic Analysis and Applications. **(04 L)**

Introduction, Different term used – Disconnection, Synthon, Synthetic equivalent, FGI, TM. Retro synthesis and synthesis of target molecules- Acetophenone, Crotonaldehyde, Cyclohexene, Benzoyl benzoate and Benzyl diethyl malonate.

Ref. 2: Relevant pages. Ref. 3: Relevant pages.

Unit 3: Rearrangement Reactions. **(06 L)**

Introduction, Mechanism of rearrangement reaction involving Carbocation, nitrene and oxonium ion intermediate. Beckmann, Bayer-Villiger, Pinacol-Pinacolone, Curtius, Favorski and Claisen rearrangement.

Ref. 7 Pg. 86-90, 150, 112, 122, 158. Ref. 6: Relevant pages.

Unit 4: Spectroscopic Methods in Structure Determination of Organic Compounds. (22 L)

A) Introduction:

Meaning of spectroscopy, Nature of electromagnetic radiation, Wavelength, Frequency, Energy, Amplitude, Wave number and their relationship, Different units of measurement of wavelength, Frequency, different regions of electromagnetic radiations. Interactions of radiations with matter, excitations of molecules with different energy levels- rotational, vibrational and electronic level.

Ref. 4: Pg.-1,3,7,11, Ref. 9 and 10: Relevant pages.

B) Ultra-Violet Spectroscopy:

Introduction, Spectrophotometer, Beer-Lambert's law, Electronic excitations, Terms used in UV spectroscopy, Effect of Conjugation on position of UV bands, Calculations of λ_{max} by Woodward and Fieser rule, Color and visible spectrum and Applications of UV spectroscopy.

Ref. 4: Pg.-13-15, 18-38.

C) Infra-Red Spectroscopy:

Introduction, Principle of IR spectroscopy, Types of molecular vibrations, Conditions of absorption of IR region, Interpretation of IR spectrum, Characteristics of IR absorption of some functional groups, Factors affecting IR frequencies, Applications of IR spectroscopy.

Ref. 4: Pg.- 46-51, 53, 54, 72-81, 86.

D) **PMR spectroscopy**:

Introduction, principles of PMR spectroscopy, magnetic and non-magnetic nuclei, processional motion of nuclei, nuclear resonance, chemical shift, shielding and deshielding, chemical shift, spin-spin coupling, coupling constant, Application of PMR spectroscopy.

Ref. 4: Pg.-95-98, 106-108.

E) **Problems**:

Spectral problems based on UV, IR and PMR data.

Ref. 1, 8 and 9**.**

Unit 5: Natural Products: **(06 L)**

(A) Terpenoids: Introduction, isolation, classification, Citral-structure (Chemical and Spectral methods) and Synthesis- Barbier and Boveault.

(B) Alkaloids: Introduction, Extraction, purification, Ephedrine-structure (Chemical and Spectral methods) and Synthesis-Nagi.

Ref. 5: Pg. -1437-1440, Ref. 6: Relevant pages

References books

1. Organic Chemistry by Morrison and Boyd 6th Edn.
2. Designing of organic synthesis by Stuart Warren 1983.
3. Organic Chemistry by Cram and Hammond.
4. Absorption spectroscopy of organic molecules by V. M. Parikh.
5. Organic chemistry by Cladden, Greeves, Warren and Wothers.
6. Organic chemistry by I. L. Finar, Vol (II), 5thEdn.
7. Reaction, rearrangement and reagents by S. N. Sanyal.
8. Introduction to spectroscopy by Pavia.
9. Spectroscopic identification of organic molecules by Silver Stein.

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CHEM 3604 Analytical Chemistry – II, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
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

Unit 1: Solvent Extraction(08 L)

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

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

Unit 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

Unit 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

Unit 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, and Introduction to super critical fluid chromatography (SFC)

Ref. 6. Pg. 529-545, Ref. 4. Pg. 178-183

Unit 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

Unit 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

Reference books

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

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CHEM 3605 Industrial Chemistry – II, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	Polymer	09
2	Industrial Organic Synthesis	08
3	Soap and Detergents	08

4	Chemistry of pharmaceutical industries	08
5	Synthetic dyes industry	08
6	Pollution prevention and waste management	07

Unit 1: Polymers(09 L)

Introduction, Classification, based on origin, based on the polymerization process, based on the molecular forces, based on the growth of polymerization, based on structure, based on the polymerization reaction, Methods of preparation and applications of Silicone polymers, Methods of preparation and applications of some polymers: Nylon-6,6, Terrylene, Polyethylene, polystyrene, polyvinyl chloride, Phenol-formaldehyde resin. Urea-formaldehyde resin, Melamine-formaldehyde resin.

Ref. 1 and 2

Unit 2: Industrial Organic Synthesis (08 L)

Manufacture of methanol from synthesis gas, Isopropanol from propylene, Glycerol from propylene via allyl chloride, Acetone by catalytic dehydrogenation of Isopropanol. (With flow sheet diagram), Unsaturated Hydrocarbon –preparation of Acetylene from Natural gas (with flow sheet), Aromatic hydrocarbon-Preparation of toluene (with flow sheet)

Ref.3: Chapter 11, Pg. 439 to 451 and Chapter 14, Pg. 493 to 522 (Relevant Points Only).

Unit 3: Soap and Detergents (08 L)

Soaps- Introduction, Importance of soap, Raw Materials used in Soap Manufacture, Manufacture of Soaps (Continuous Process), Cleansing action of Soap and detergents, Classification of Soaps.

Detergents- Introduction, Advantages and disadvantages of Detergents, Surfactants and detergent, Emulsion and Emulsifying agents, Wetting and Non-wetting agents, Hydrophobic and Hydrophilic nature, Micelles, Types of surfactants, Detergent's builders and Additives, Manufacture of detergents, Comparison between Soap Detergent.

Ref.4

Unit 4: Chemistry of pharmaceutical industries (08 L)

Introduction - Importance, Qualities of good drugs, Classification of drugs, Functional and chemotherapeutic drugs, Meaning of the terms: Prescriptions, Doses, Analgesic, Antipyretics, Diuretics, Anaesthetics, Antibiotics, sulpha drugs, Anti-inflammatory, Tranquilizers, Anti-viral, Cardiovascular, Cough and Cold Preparations, Sedatives and Hypnotics, contraceptives, Anti-ulcer. Synthesis and uses of Paracetamol, Sulphanilamide, Benzocaine, Manufacture of Aspirin with flow sheet, Chloramphenicol, Penicillin-G, Diazepam.

Ref.3: Pg.762-775; Ref.5: Pg. 803-804, 818-822, Ref.6: Pg. .987-1011

Unit 5: Synthetic dyes (08 L)

Introduction - Importance, Qualities of good dye, colour and chemical constitution, Classification based on the chemical constitution, Witt's theory.

Meaning of terms: chromospheres, auxochrome, bath chromic (red) and hypsochromic (blue) shifts.

Synthesis and uses of Methyl orange, Malachite green, phenolphthalein, Rosaniline, crystal violet, Florescence, Alizarin, Indigo. Pigments: Introduction, classification, and general physical properties.

Ref.3: Pg. 777-814; Ref.7: Pg. 863-915; Ref. 8. Ref. 9

Unit 6: Pollution prevention and waste management (07 L)

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. 3: Pg. 8-92; Ref.10: Pg. 15-30; Ref. www.wikipedia.org/atom economy

Reference books

1. Polymer materials C. C. Winding, and G.D. Hiatt Mc Grow Hill Book Co.
2. Polymer science by Gowarikar.
3. Polymer science, Bill Meyer, F.W. Jr. John Wiley and Sons.
4. Industrial Chemistry, B. K. Sharma, 16th Edition, Goal Publishing House, Meerut, (U.P.) 2011, India.
5. Perfumes Soaps Detergents & Cosmetics (Soaps & Detergents) (Volume 1) 1st Edition, CBS Publisher.
6. Shreve's chemical process industries 5th Edition, G.T. Oustin, McGraw Hill
7. Riegel`s handbook of Industrial chemistry, 9th Edition, James A. Kent.
8. Industrial chemistry –R.K. Das, 2nd Edition, 1976.
9. Dyes & Paints: A Hands-On Guide to Coloring Fabric, by Elin Noble.
10. Emergency Medicine: Chapter 146 Insecticides, Herbicides & Rodenticides, by James Adams.

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OPTIONAL THEORY PAPER- Select ANY ONE of the following

CHEM 3606(A) Nuclear Chemistry – II, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	NuclearFission	10
2	NuclearReactors	08
3	NuclearAccelerators	08
4	Detectionandmeasurementofnuclearradiations	08
5	ApplicationsofRadioactivity	10
6	RadiationSafetyprecautions	04

Unit 1. NuclearFission (10L)

Introduction, Discovery of nuclear fission, The process of nuclear fission, Fission fragments andtheirmassdistribution,Fissionenergy,Fissioncross-sectionandthresholds,Fissionneutrons,Theoryofnuclearfission**.**

Ref.1:Pg. 209to225

Unit 2. NuclearReactors (08L)

The fission energy, The natural uranium reactor, The four factor formula, The classification ofreactors.Reactor power,Critical sizeofa thermalreactor, Breeder reactor,The fastbreedertestreactoratKalpakkam,India'snuclearenergyprogramme.

Ref.1:Pg. 232to249

Unit 3. NuclearAccelerators **(08L)**

ElectrostaticAccelerators,Thecockcroft-waltonAccelerator, TheVande-GraftAccelerator,CyclicAccelerator,LinearAccelerator**.**

Ref:2Pg.290to305,325to330

Unit 4. Detectionandmeasurementofnuclearradiations **(08L)**

ScintillationCounters,Semiconductordetectors,Neutrondetectors.

Ref.2Pg.211to222.

Unit 5. ApplicationsofRadioactivity **(10L)**

Probing by isotopes, Typical reactionsinvolved in the preparation of radioisotopes, Szilard-Chalmer reaction,Cow andmilksystem,Use of charged plates inthecollection of radioisotopes,Radiochemicalprinciplesintheuseoftracers,Analyticalapplications:Isotopedilutionanalysis, Neutronactivationanalysis,Radiometrictitrations,Numericals,medicalapplicationsa)thyroidisis(Goiter),b) radioimmunoassay.

Ref.1Pg. 309to328,338to345

Unit 6. RadiationSafetyprecautions **(04L)**

Safetystandards,safeworkingmethods,biologicaleffectsofradiations,nuclearwasteanditsmanagement.

Ref.3Pg.322to328

Reference books

1. EssentialsofNuclearChemistrybyH.J.Arnikar,4th RevisedEdition,NewAge,
2. SourcebookofAtomicenergybySamuelGlasstone,3rdedition,East-Westpress.
3. NuclearPhysicsbyIrvingKaplan,2ndedition.
4. IntroductiontoNuclearphysicsandchemistrybyB.G.Harvey.
5. FundamentalsofRadiochemistrybyD.D.Sood,A.V.R.ReddyandN.Ramamurthy.

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CHEM 3606 (B) Polymer Chemistry – II, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	PolymerDegradation	03
2	ChemicalandGeometricalstructuresofPolymerMolecules	04
3	GlassTransitionTemperatureandHeatDistortion Temperature(SofteningPoint)	05
4	Crystallinityinpolymers	04
5	SomeImportantPolymers	08
6	Analysisandtestingofpolymers	06
7	SomeSpecialPolymers	06
8	PolymerProcessing	12

Unit 1. PolymerDegradation **(03L)**

Introduction,TypesofDegradation,Thermaldegradation,Mechanicaldegradation.Photodegradation.

Ref.1:Pg.262–277, Ref.3:Pg.151-160, Ref.4:RelevantPages, Ref.11:Pg.60-65

Unit 2. ChemicalandGeometricalstructuresofPolymerMolecules **(04L)**

Microstructuresbasedonchemicalstructures -Organic&Inorganicpolymers,Homo chain & Hetero chainpolymers,Homopolymers &Copolymers,

Microstructuresbasedongeometrical structures -Interpenetrating coils, folded chain, Helical chain, Linear, Branched, Random,Alternating,GraftandBlockpolymers.

Stereo-regularpolymers -OpticalandGeometricIsomerism.

Ref1:Pg.136-149, Ref4:RelevantPages

Unit 3. Glass Transition Temperature (GTT) andHeatDistortionTemperature (SofteningPoint)

(05L)

Definition, Factors influencing the Glass transition temperature, Glass transition temperatureand molecularweight,Glasstransition temperature and plasticizers,GlassTransitionTemperatureandCrystallinemeltingpoint(Tm),ImportanceofGlasstransitiontemperature.

Ref1:Pg.150,163-169,171-172,219, Ref4, Ref9:Pg.113-116, Ref10:Pg.47-58

Unit 4. Crystallinityinpolymers(04L)

Introduction, Degree of Crystallinity, Crystallisability, crystallites, Factors affectingCrystallisability, Effectofcrystallinityonthepropertiesofpolymers.

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

Unit 5. SomeImportantPolymers(08L)

Polystyrene,Polymethylmethacrylate,Polyester,Polycarbonates,Polyamides,Polyvinylalcohol(PVA),Polyvinylchloride(PVC),Polytetrafluoroethylene(Teflon)&polyvinylfluoride,lyisoprene,Polyimide,Phenolformaldehyderesin(Novolac),Ureaformaldehyderesin,Epoxypolymers.

Ref.1:Pg.213-254, Ref.3:RelevantPages, Ref.4:RelevantPages, Ref.8:RelevantPages

Unit 6. Analysisandtestingofpolymers (06L)

SpectroscopicMethods:IR,NMR,Thermalanalysis:DifferentialScanningCalorimeter(DSC), ThermoGravimetricAnalysis(TGA),Physicaltesting:Mechanicalproperties,Thermalproperties, Opticalproperties,Electricalproperties,Chemicalproperties.

Ref2:Pg.229-237,242-252, Ref4:Pg.121-139

Unit 7. SomeSpecialPolymers (06L)

Polymerblends,Bio-medicalpolymers, Biodegradable polymers,LiquidCrystallinepolymers(LC's), Conductingpolymers,thermallystable polymers,Optical fibers,

Ref.4:RelevantPages, Ref.6:Pg.179,185,197, Ref.7:Pg.262-299, Ref.9:Pg.130-162

Unit 8. PolymerProcessing (12L)

PlasticTechnology (04 L)

1.Molding2. Extrusion3. Otherprocessingmethods:Calendaring,FilmCasting,Coating,Foaming,Forming,Laminating&Lowpressure molding,Compounding.

Ref.2:Pg.457-469,474-475., Ref.1,4,6,7,9: Relevantpages

FiberTechnology (04 L)

1.Introduction,Textile&Fabricproperties,2.FiberSpinning:i)Meltspinningii)Dryspinning iii)Wetspinningand3.Fiberaftertreatments:Scouring,Lubrications,Sizing,Dyeing,Finishing,Textureyarns, Nonwovenfabrics.

Ref2:Pg.486-501, Ref.1,4,6,7,9: Relevantpages

ElastomerTechnology (04 L)

1. Introduction,Vulcanization(Sulphur&nonSulphurvulcanization),2.Reinforcement,ElastomerCompoundin

g.

Ref.2:Pg.506-518, Ref.1,4,6,7,9: Relevantpages

ReferenceBooks

1. PolymerSciencebyV.R.Gowarikar,N. V. Vishwanathan,Jaydev ShreedharNewAge
2. TextbookofPolymerSciencebyFredBillmeyer,3rdEdn.JohnWiley &Sons(Reprint2008)
3. IntroductoryPolymerChemistrybyG. S. MisraNewAgeInternational(P)Ltd.Publisher1996.
4. PolymerChemistrybyCharlesE.Carraher(Jr.),6thEdn,(FirstIndianPrint2005),
5. InorganicPolymersbyG. R. ChatwalHimalayaPublishingHouse1stEdn.1996
6. PolymerScience–ATextBookbyV.K.Ahluwalia,AnuradhaMishra.
7. PrincipleofPolymerSciencebyP.Bahadur,N.V.Sastry,2ndEdn,NarosaPublishingHouse.
8. PolymerChemistrybyAyodhyaSingh,2008,CampusBookInternational,NewDelhi.
9. OrganicPolymerChemistrybyJagdambaSingh,R.C.Dubey,4thEdn,2012.
10. AdvancedPolymerChemistrybyV.K.Selvaraj,1stEdn,2008,CampusInternational,NewDelhi.
11. OrganicPolymerChemistrybyV.Jain,IVYPublishingHouse,NewDelhi.
12. PrinciplesofPolymerizationbyGeorgeOdian3rdEdn.JohnWiley&SonsNewYork.

CHEM 3606 (C): IntroductiontoBiochemistry&MolecularBiology– II
(03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	IntroductiontoMetabolism	02
2	Carbohydratemetabolism	06
3	Lipidmetabolism	04
4	Aminoacidmetabolism	04
5	ElectronTransportChainandOxidativePhosphorylation	06
6	Nucleicacids	07
7	DNAreplication	06
8	Transcription	05
9	Translation	04
10	IntroductiontoGeneticengineering	04

Unit 1. IntroductiontoMetabolism: (02L)

Definitionofcatabolismandanabolism,Typesofmetabolicreactions,Highenergycompounds,Significanceof ATP.

Ref:3,Chapter12,Pg. 247-249andChapter11 P g . 227-230.

Unit 2. CarbohydratemetabolismandTCAcycle (06L)

Aerobicandanaerobicglycolysis-structuresofintermediates,variousenzymesinvolvedandenergetics. Fate of Pyruvate, Pyruvate dehydrogenase complex. TCA cycle- enzymatic reactions andenergetics.

Ref:2,Chapter17:Pg. 136-144andChapter16:Pg. 130-135

Unit 3. Lipidmetabolism (04L)

Transportation of fatty acids with the help of carnitine, β-oxidation ofpalmiticacid inmitochondriaanditsenergetics. Triacylglycerolsynthesis,ketogenesis.

Ref :2,Chapter22,Pg. 180-189.

Unit 4. Aminoacidmetabolism: (04L)

Significanceoftransamination,deamination,decarboxylationreactionsofaminoacids. Ureacycle.

Ref:2,Chapter29, Pg. 242-248

Unit 5. ElectronTransportChainandOxidativePhosphorylation: (06L)

Location of Electron carriers, Electron transport chain, Proton gradient, Oxidative phosphorylation-Chemiosmotichypothesis,InhibitorsandUncouplersofElectrontransportchainandOxidativephosphorylation.

Ref:3,Chapter11,Pg. 230-239.

Unit 6. Nucleicacids: (07L)

StructuresofPurinesandPyrimidines,Nucleosides,Nucleotides,Polynucleotides. Differencebetween DNAand RNA. Watsonand Crick model of DNA. DNAas geneticmaterial (Macleod andMcCarty,HersheyandChaseexperiments) RNAanditstypes. Centraldogmaofmolecularbiology.

Ref:3,Chapter5,Pg. 73-83.

Unit 7. DNAreplication: (06L)

Semiconservative model of replication (Meselson and Stahl experiment). Brief account of initiation (features of Ori C), elongation and termination of DNA replication in prokaryotes. Okazaki fragments,Leading and Lagging strands, Distinguishing features of DNA polymerase I, II and III. Klenow fragmentofDNA polymeraseI.

Ref:1,Chapter25,Pg. 950-984

Unit 8. Transcription: (04L)

Briefaccountofinitiation-Promotersequences,elongationandterminationoftranscriptioninprokaryotes.RNApolymerase.Examplesofinhibitorsoftranscription.Chapter26:996-1027

Ref:1,Chapter26, Pg. 948–1033.

Unit 9. Translation: (05L)

Genetic code and its features. Brief account of initiation, elongation and termination of translation inprokaryotes. Examplesofinhibitorsoftranslation. Regulationofgeneexpression-Lacoperon.

Ref:1,Chapter27,Pg. 1034-1075.

Unit 10. Introductiontogeneticengineering: (04L)

Basicconceptsofgeneticengineering-RestrictionEnzymes-Typesandfeatures,Vectors(Plasmids PhagesandCosmids)RecombinantorChimericvector.PrincipleandStepsinvolvedingenecloningwithinsulinasexample.Applicationsofgeneticengineeringinvariousfields.

Ref:1,Chapter9,Pg. 307-310,311-313,Chapter2,Pg. 15.

ReferenceBooks

1. Lehninger's,PrinciplesofBiochemistry,byNelsonandCoxMacmillanPublisher4th edn.
2. Harper'sIllustratedBiochemistry,26thEdition.
3. BiochemistrybyU.Satya Narayana
4. Biotechnology,B. D. Singh,3rdedition.
5. Cellbiology,Genetics,MolecularBiology,EvolutionandEcology,byVermaandAgarwal,14thedition.
6. PrincipletechniquesofBiochemistryandMolecularBiologybyKeithWilsonandJohnWalker,6thedition.
7. BiophysicaltechniquesbyUpadhyayandNath,3rdrevisededition.

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CHEM 3606 (D): EnvironmentalandGreenChemistry– II, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	Watertreatmentandeffluentmanagement	08
2	Soilandsolidwastemanagement	04
3	Instrumentalmethodsinenvironmentalanalysis	08
4	GreenHouseEffectandGlobalWarming	04
5	WatertheultimateGreensolvent	12
6	EnergyRelations	12

Unit 1:Watertreatmentandeffluentmanagement (08 L)

Domesticsewage,wastewatertreatment:primary,secondaryandtertiarytreatments, aerobic,anaerobicandup flowanaerobic sludgebedtreatmentprocesses
Industrialwastewatertreatmenti)filtrationmethodii)ion-exchangemethod
iii)membranetechniques:ultrafiltration, reverseosmosisandelectro dialysis
Treatmentofdrinkingwater

Ref.1,Ref.2,Ref.3

Unit 2:Soilandsolidwastemanagement (04 L)

Compositionofsoilandtypesofsoil., Organicandinorganiccomponentsofsoil
AcidbaseandionexchangereactionsinsoilandpHofsoil
Chemistryofdisposalofsolidwastei)sanitarylandfillsii)incineratorsiii)pyrolysis

Ref.1,Ref.2,Ref.3

Unit 3:Instrumentalmethodsinenvironmentalanalysis(08 L)

Atomicabsorptionspectroscopy:determinationofHg,As,Zn,Ag,Pb,Mn,Fe,Cu,Cr,Cd
Gaschromatography:detectionanddeterminationofCO,HCandpesticides
HPLC:determinationofpesticides,PAHasmetabolites
Spectrophotometry:determinationofNOx,SO_2,NH_3,CN,PO_4,Cd,Pb,Hg
Chemiluminescence:determinationofNOxandO_3.
NonDispersiveIRspectrometryofdeterminationofCO
Ionselectiveelectrodes:determinationofNO_3anddissolvedoxygen(D.O.)

Ref.1,Ref.2

Unit 4:GreenHouseEffectandGlobalWarming(04 L)

Introduction, Greenhousegases, Radiativeforcing, SourcesandsinksofCO_2
Causesoffluctuationsinglobaltemperature, Globalwarmingandclimatechanges
Implicationsofclimatechanges

Ref.5

Unit 5.WatertheultimateGreensolvent(12 L)

H_2O:Simpleformulaandcomplexmolecule, Importantpropertiesofwater
Thehydrologiccycle, Bodiesofwaterandlifeinwater, Chemicalprocessinwater
Fizzywaterfromunderground, Oxygeninwater, Weakacidfromsky
Whynaturalwatercontainsalkalinityandcalcium, Metalsinwater,
Waterinteractionswithotherphases

Ref:GreenChemistrybyStanley EManahan,ChemcharResearchInc.(2006)- 2nd EdnChapter7:Pg. 161-173

Unit 6. EnergyRelations: (12 L)

Energy, RadiantEnergyfromtheSun, Storageandreleaseofenergybychemicals Energysources, Conversionsbetweenformsofenergy, Greenengineeringandenergyconversion Efficiency, Conversionofchemicalenergy, Renewableenergysources

Ref:GreenChemistrybyStanleyEManahan,ChemcharResearchInc.(2006)- 2nd EdnChapter6:Pg. 135-157

ReferenceBooks

1:EnvironmentalChemistry–A.K.De,5thEdition(Newageinternationalpublishers)
2:EnvironmentalChemistry–J.W.MooreandE.A.Moore(AcademicPress,NewYork)
3:EnvironmentalChemistry–A.K.BhagiandC.R.Chatwal(HimalayaPublishingHouse)
4:AnalyticalChemistry–G.D.Christian4thEdition(JohnWileyandSons)
5:EnvironmentalChemistry–H.Kaur2ndEdition2007,Pragati Prakashan,Meerut,India
6.EnvironmentalChemistrywithGreenChemistryA.KDas,BooksandAllied(P)Ltd,

CHEM 3606 (E): DairyChemistry, (03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	MarketMilk	08
2	CommonDairyProcesses	06
3	SpecialMilks	08
4	Milkproteins,CarbohydratesandVitamins	08
5	Preservatives&AdulterantsinMilk	06
6	MilkProducts	08
7	DriedMilkProducts	04

Unit 1. MarketMilk (08L)

Introduction, Definition, constituents ofmilk of different species suchas cow, buffalo, goat,etc.,Chemicalcompositionofmilkof Indianbreedandforeignbreedsofcow,factoraffectin gcomposition of milk, characteristics of milk of different mammals, physicochemical properties of milk,acidity,pH,density,specificgravity,colorandflavorofmilk,foodandnutritivevalueofmil k.Microbiologyofmilk,growthofmicroorganism,stagesofgrowth,productofmicrobialgrowth ,destructionofmicroorganism'sgrowth.

Ref1, Ch.1relevantpages,Ref2Pg. 9-26,Ref6relevantpages.

Unit 2. CommonDairyProcesses(Manufacture,storageandpackaging) **(06L)**

Cream separation- Basic principles, gravity creaming water dilution and centrifugal creamingmethod, 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 ofmilk,flowsheetdiagram,processreceivingmilk,preheatingfiltration,clarification,coolinga ndstoragerawmilk,standardization,pasteurization,homogenization,packingandstorage,uses ofmilk.

Ref1.-Relevantpages.

Unit 3. SpecialMilks (08L)

Sterilizedmilk-Definition,methodofmanufactureindetail,Advantagesanddisadvantages. Homogenized milk, - Definition, merits and demerits factor influencing homogenization, Process ofmanufacture. Soft curd milk- Definition, characteristics, method of preparation of soft curd milk. Flavoredmilk-Definition,types,methodofmanufactureflowsheetdiagram.Vitaminised/irradiatedmilk--Definition,methodofmanufacture.FermentedMilk-Definition,methodofmanufacture.Standardizedmilk-Definition,methodofmanufacture.

Ref1Ch. 2relevantpages**.**

Unit 4. Milkproteins,CarbohydratesandVitamins (08L)

Milkproteins-importanceofproteinsfoundinthemilk-casein,albuminandglobulin,composition,nomenclature,propertiesanduses.2.Carbohydrates-importanceoflactose,classification,properties,nutritivevalueoflactoseuseoflactose.3.Vitamins-importance,definition, propertiesnutritivevalueofvitamins,Vit-A,Vit-B,B2,B6,B12,Vit-C(Ascorbicacid)&Vitamin-D.4.Food andnutritive valueofmilk,milk&public health.

Ref - 2Pg.11,12,33to38,42to49,51to53

Unit 5. Preservatives&AdulterantsinMilk (06L)

Preservationofmilk-Introduction,Commonpreservativesareused..

Adulterants-Introduction, Modes of Adulteration and their detection such as skimming, addition of separated milk,skimmilk,Water,Starchandcanesugar.

Ref-2Pg.78-81

Unit 6. MilkProducts(Cream,Butter,CheeseandIce-Cream.)**(08L)**

1. Cream- Definition, Classification, Composition, Food & Nutritive value, Physicochemical properties,Manufacture andusesofcream.

   Ref-1 Pg.117,118,121 &142

2. Butter- Definition, Classification, Composition, Food & nutritive value, Physicochemical properties,ManufactureandusesofButterselectionofmilk/cream.Preheatingofmilk,separatingofmilk,neutralization of cream, Pasteurization of cream, Cooking & ageing, repenting of cream, salting ofbutter, washingofbutter,packaging& Storage, use ofbutter.

   Ref-1Pg.143,144,145to158&173

3. Cheese- Definition,Classification,Food&nutritivevalue,properties,Manufactureandusesofcheese.

   Ref-1Pg.224,227,229to242&267

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

   Ref-1Pg.182,183,184,193,223

Unit 7. DriedMilkProducts (04L)

Introduction,buttermilkpowder,wheypowder,creampowder,infectmilkpowder,Shrikand powder,Ice-creammix powder, cheese powder.

Ref-1Pg. 357to 377

Reference books

1. OutlineofDairyTechnology-OxfordUniversityPressBy-SukumarDe.(Edition-1983)
2.DairyChemistryandAnimalNutrition-M.M.Rai,Kalyani,Publishers,3rdEdition,1980
3.FundamentalsofDairyChemistry-B.H.Webb,A.H.Hooson,J.A.Alford,CBBPublishers
4.MilkandMilkProducts-C.H.Eckles,H.Macy,TataMcGrawHikePublishing CompanyLtd.
5.ChemistryandTestingofDairyProducts-H.V.Atherton,J.A.New Lander,CBS,PublishersandDistributors.

6.DairyMicrobiology,Dr.K.C.Mahanta OmsonsPublicationNewDelhi.

CHEM 3606 (F): EnvironmentalNanotechnologyandApplications
(03 Credits, 48 Lectures)

Unit No.	Unit	No. of Lecture
1	WaterPollution	12
2	Airpollution	12
3	Nanomaterialsforsensingtoxicgases	12
4	MesoporousmaterialsforEnvironmentalApplications	12

Unit1: WaterPollution: (12L)

WaterPollution,sourcesandmanagementofwaterpollution,needforwatermanagement, waste water collection, physicochemical properties of waste water, waterand waste water treatment, physical, chemical and biological treatment process, activatedsludge, oxidation ditches, trickling filter, rotating discs, rotating drums, oxidation ponds,Anaerobicdigestions,anaerobicfilters,upflowanaerobicsludgeblanketreactor,treatmentschemesforwaterofdairy,distillery,sugarand antibioticindustries.
Groundwaterpollution,Sources,effectcontrol,consequencesofgroundwaterpollution.
Drinking water, domestic and industrial waste water, nanotechnologies used in watertreatments,effluenttreatment.
Environment (Protection) act-1986, the water (prevention and control of pollution) act-1974

Unit2: Airpollution: (12 L)

Air pollution, methods for the measurement of air pollution and its control, pollution in the atmosphere.
Toxicity due toair-borne nanomaterials,engineerednanomaterialsin the environment andhealtheffects of nanoparticlesthroughair,absorption,pulmonary depositionof nanoparticles,eliminationofdustdepositedinthe lungs,nanoparticles.
Absorptionintheair, effectofultrafinedust
Theair (preventionand controlofpollution) act-1981,cleanair actandnanotechnology.

Unit3: Nanomaterialsforsensingtoxicgases: (12L)

Gas sensing materials and devices, Techniques used for gas sensing (resistance, capacitanceandelectrochemical),Sensorproperties,advantagesofnanomaterials, synthesisandcharacterizationofNano-metaloxides(tinoxide,zinc oxide,indium

oxide), mixed oxides, nanoscale materials for sensors (quantum dots, CNTs, nanotubes, wires andbelts), colloidal silver and gold,magneticnanoparticles, application of nanomaterialsin sensors,CNT-basedsensors,Graphene-basedsensors,activedevicesbasedonNanostructures.

Unit4: MesoporousmaterialsforEnvironmentalApplications:(12L)

Why mesoporous materials? Hierarchy of solid structure and adsorption, mesoporous silicaanditsapplicationtotheabsorptionoftoxicanions,importantcharacteristicsforEnviron mental applications, nanocomposites for environmental applications, CeO_2catalystsand CO catalytic oxidation, metal loaded CeO_2/ ZrO_2catalysts, application of mesoporousTiO_2inPhoto catalysis,mesoporous materialsasAdsorbents.

ReferenceBooks

1. EnvironmentalapplicationsofNanomaterials:Synthesis,sorbentsandsens ors (2 ndEdition)Editors:GlenE. FryxellandGuozhongCao,ImperialCollegePress
2. MetalOxideNanostructuresasGasSensingDevices,G.Eranna,CRC Press, ATaylorandFrancisBook,
3. EnvironmentalChemistry,A.K.De,WileyWesternLtd,NewDelhi,2003
4. Waste waterEngineering-Treatment, Disposal andReuse, Metcalf andEddy, Inc.,TatMcGrawHill,1999
5. StandardmethodbyAmericanpublichealthassociation(APHA),2005
6. Waterandwaste wateranalysis (Handbookofmethods inenvironmentalstudies)byS.K.Maiti, ABDPublication,Delhi,ISBN-978-81-8577-34-07

CHEM 3607: Physical Chemistry Practical – II, (02 Credits, 10 Practicals)

(Any **TEN Experiments** from the given list of Experiments)

Group – A: Non Instrumental Experiments (ANY FIVE)

1. To investigate the adsorption of oxalic acid /acetic acid by activated charcoal and test the validity of Freundlich / Langmuir isotherm.
2. To study the effect of change in concentration of sodium thiosulphate on the rate of reaction between sodium thiosulphate and hydrochloric acid.
3. To determine the energy of activation of the reaction between potassium iodide and potassium persulphate for an unequal concentrations of the reactants.
4. To determine the first order velocity constant of the decomposition of hydrogen peroxide by volume determination of oxygen.
5. To study the kinetics of iodination of acetone.
6. Interpretation of Spectra: Rotational spectra of diatomic molecules CO/ HCl/ DCl or triatomic molecules CO_2 / HCN.
7. Interpretation of Spectra: Infrared spectra of ethanol/allyl alcohol.
8. Report on Industrial Visit: To prepare a report on the study physical properties observed in industry.

Group – B: Instrumental Experiments (ANY FIVE)

1. To investigate the Conductometric titration of mixture of strong and weak acid against strong base.
2. To determine the amount of dibasic acid (Oxalic acid) by Conductometric titration against strong base.
3. To determine the dissociation constant of oxalic acid by pH-metric titration with strong base.
4. To determine pH of various mixtures of sodium acetate and acetic acid in aqueous solution and hence to find the dissociation of acetic acid.
5. To determine the formal redox potential of Fe^{2+}/ Fe^{3+} system potentriometrically.
6. To determine the amount of NaCl in the given solution by potentiometric titration against silver nitrate.
7. To titrate Cu^{2+} ions with EDTA photometrically.
8. To determine the indicator constant of methyl red indicator.
9. To determine plateau voltage of the given G M counter.
10. To determine the resolving time of GM counter.

Reference books:

1. Practical Physical Chemistry, 3rd ed. A. M. James and F. E. Prichard, Longman publication.
2. Experiments in Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.

3. Advanced Practical Physical Chemistry, J. B. Yadav, Goal 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.
6. Comprehensive experimental Chemistry, V. K. Ahluwalia and S. Raghav, New Age International
7. Senior Practical Physical Chemistry, Khosla, B. D.; Garg, V. C. & Gulati, A. R. Chand & Co.: New Delhi (2011).
8. Experiments in Physical Chemistry, Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. 8th ed.; McGraw-Hill: New York (2003).
9. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd ed.; W.H. Freeman & Co.: New York (2003).
10. Athawale V. D. and Mathur P. Experimental Physical Chemistry, New Age International (2001)

Que. No.	Experiment	Max. Marks
1	One Experiment from Group – A	25
2	One Experiment from Group - B	25
3	Oral	10
	Total Marks	**60**

Structure of Practical Examination

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CHEM 3608: INORGANIC CHEMISTRY PRACTICAL- II, (02 Credits,10 Practicals)

A) **Qualitative Analysis:** (Minimum **FOUR** mixtures including Borates and Phosphates)

B) Volumetric Estimations (Any **THREE** of the following)

1. Mn by Volhard's method
2. Estimation of NO_2 - by using $KMnO_4$.
3. Estimation of titanium
4. Analysis of Brass-Estimation of copper by Iodometry
5. Fertilizer analysis (PO_4)

C) Separation of binary mixture of cations by Column Chromatography (THREE mixtures**)**
(One mixture should be colourless, Zn + Al, Zn + Mg)

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

Reference Books

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

Structure of Practical Examination

Que. No.	Experiment	Max. Marks
1	Qualitative analysis	35
2	(Any **ONE** of the following) • Volumetric Estimation • Coloumn Chromatography	15
3	Oral	10
Total Marks		**60**

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CHEM 3609: Organic Chemistry Practical – II, (02 Credits, 10 Practicals)

A) Separation of Binary Mixtures and Qualitative Analysis (ANY FOUR MIXTURES)

Solid-Solid (2 Mixtures), Solid-Liquid (1 Mixture), Liquid-Liquid (1 Mixture).
At least one mixture from each of the following should be given -
(Acid-Base, Acid-Phenol, Acid-Neutral, Phenol-Base, Phenol-Neutral, Base-Neutral, 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 (ANY **TWO**)

1. Estimation of Ethyl benzoate.
2. Determination of Molecular weight of dibasic acids by volumetric Methods.
3. Estimation of glycine.

C) Organic Preparations (ANY **FOUR)**

1. Benzoic acid from Ethyl benzoate (Ester hydrolysis).

2. p-Bromacetanilide from Acetanilide (Bromination).
3. p-Acetomol from p-Hydroxyaniline (Acetylation).
4. Ethyl benzene from Acetophenone (Wolff -Kishner reduction).
5. Multicomponent reaction - Preparation of Dihydropyrimidone.
6. Base catalysed Aldol condensation- Preparation of Dibenzal propanone.
7. Diels Alder reaction- Reaction between Furan and Maleic acid.

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. Vogel.

2) Practical Organic Chemistry by – O. P. Agarwal.

Structure of Practical Examination

Que. No.	Experiment	Max. Marks
1	Binary Mixture separation and qualitative Analysis	30
2	Organic Estimation/ Preparation	20
3	Oral	10
Total		**60**