Fergusson College (Autonomous)
Pune

Curriculum for

T. Y. B. Sc. Chemistry

With effect from June 2021

Fergusson College (Autonomous), Pune
Structure of T. Y. B. Sc. (Chemistry)
Under CBCS pattern (2019) ***effective from June 2021***

Sem.	Paper No.	Course code	Title	Credits	CE maximum Marks	ESE maximum Marks	Total maximum Marks
V	DSE-1A	CHE3501	Physical Chemistry I	2	50	50	100
	DSE-1B	CHE3502	Inorganic Chemistry I	2	50	50	100
	DSE-2A	CHE3503	Organic Chemistry I	2	50	50	100
	DSE-2B	CHE3504	Analytical Chemistry I	2	50	50	100
	DSE-3A	CHE3505	Industrial Chemistry I	2	50	50	100
	DSE-3B	CHE3506	Biochemistry I	2	50	50	100
	DSE-1	CHE3507	Physical Chemistry Practical I	2	50	50	100
	DSE-2	CHE3508	Inorganic Chemistry Practical I	2	50	50	100
	DSE-3	CHE3509	Organic Chemistry Practical I	2	50	50	100
	SEC-1*	CHE3511	Chemical Lab Safety and Waste management	2	50	50	100
	SEC-2*	CHE3512	Pharmacology	2	50	50	100
			Total Credits	**22**			**1100**
VI	DSE-4A	CHE3601	Physical Chemistry II	2	50	50	100
	DSE-4B	CHE3602	Inorganic Chemistry II	2	50	50	100
	DSE-5A	CHE3603	Organic Chemistry II	2	50	50	100
	DSE-5B	CHE3604	Analytical Chemistry II	2	50	50	100
	DSE-6A	CHE3605	Industrial Chemistry II	2	50	50	100
	DSE-6B	CHE3606	Biochemistry II	2	50	50	100
	DSE-4	CHE3607	Physical Chemistry Practical II	2	50	50	100
	DSE-5	CHE3608	Inorganic Chemistry Practical II	2	50	50	100
	DSE-6	CHE3609	Organic Chemistry Practical II	2	50	50	100
	SEC-3*	CHE3611	Polymer Chemistry	2	50	50	100
	SEC-4*	CHE3612	Analytical Methods	2	50	50	100
			Total Credits	**22**			**1100**

* ***For SEC courses - CE and ESE exam will be conducted by the department. It will not be conducted centrally***.

Note:

1. **DSE (Department Specific Elective**) - 12 Courses selected by the department. The list provided by UGC CBCS pattern for T. Y. B. Sc. is suggestive in nature and each department has a complete freedom to suggest their own papers under this category based on expertise, specialization, requirements, scope and need.
2. **SEC (Skill Enhancement courses)** - Minimum 4 for T. Y. B. Sc. These courses may be chosen from pool of courses designed to provide value-based and/or Skill-based knowledge and should contain both theory and lab/hands-on-training/field work. The main purpose of these courses is to provide students life-skills in hands on mode so as to increase their employability. The list provided by UGC is suggestive in nature and each department has freedom to suggest their own papers under this category based on expertise, specialization, requirements, scope and need.

T. Y. B. Sc. Chemistry Semester 5		
Title of the Course and Course Code	**Physical Chemistry I (CHE3501)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Define and outline the fundamentals of molecular spectroscopy, electrochemistry and quantum chemistry.	
CO2	Discuss the types of spectroscopic methods (rotational, vibrational and Raman spectra) and use these to interpret the molecular structures.	
CO3	Classify electrochemical cells and predict the spontaneity and non-spontaneity of reactions using concepts of thermodynamics. Explain the applications of EMF measurement.	
CO4	Apprise the concepts, equations and principles of classical and quantum mechanics. Explain the formulation of Schrödinger equation and apply it to 1D and 3D box.	
CO5	Compare and connect the analogy between particle in box and Jhan Teller distortion	
CO6	Solve the numerical based on molecular spectroscopy, electrochemistry and quantum chemistry.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Investigations of Molecular Structure** 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.	**12**
II	**Electrochemical Cells** 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, Types of batteries, applications of EMF measurement, such as: a. Solubility product of sparingly soluble salt b. Determination of pH c. Potentiometric titration	**12**
III	**Quantum Chemistry** Failures of classical mechanics, black body radiation, photoelectric effect, Concept of quantization, atomic spectra (no derivation), wave particle duality, uncertainty principle, 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, Jhan-Teller distortion), applications to conjugated systems such as butadiene, hexatriene and β-carotene.	**12**

References:

1. Fundamentals Molecular Spectroscopy by C. N. Banwell
2. Principles of Physical Chemistry, Fourth Edition by S. H. Maron and C. F. Prutton
3. Physical Chemistry - A Molecular Approach by Donald A. McQuarrie, John D. Simon
4. Quantum Chemistry by Donald Mcquarrie
5. Fundamentals of Quantum Chemistry by James E. House.

T. Y. B. Sc. Chemistry Semester 5		
Title of the Course and Course Code	**Inorganic Chemistry I (CHE3502)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall and outline the fundamental theories of Chemical Bonding.	
CO2	Explain Molecular orbital theory including features and formation of MO's by LCAO principles. Extend this to homonuclear diatomic, heteronuclear diatomic and triatomic molecules.	
CO3	Discuss the assumptions and concepts of Crystal Field theory and illustrate the splitting of d-orbitals in octahedral and tetrahedral field along with distribution of electrons. Calculate and compare 10 Dq, CFSE, magnetic moment for Oh and Td complexes.	
CO4	Define organometallic compounds and classify them on the basis of hapticity. Discuss structure and bonding. Calculate 18-electon rule and apply to infer stability of organometallics.	
CO5	State and explain symmetry elements and symmetry operations. Label with diagram axis, plane and centre of symmetry. Combine symmetry elements and determine point group applying systematic approach.	
CO6	Explore the MO Theory of Octahedral Coordination Complexes, Ligand field theory. Illustrate the concepts of CLO.	

Unit No.	**Title of Unit and Contents**	**No. of Lectures**
I	**Molecular Orbital Theory** Limitations of Valence Bond theory (VBT), Need of Molecular orbital theory (MOT), Molecular orbital concept of bonding, Linear combination of atomic orbitals (LCAO) (elementary pictorial approach): Different types of combination of Atomic orbital (AO's): s-s, s-p, p-p and d-d, Non-bonding combination orbitals (formation of NBMO), M.O. Orbital designations, HOMO, LUMO. Energy level diagram for homonuclear diatomic molecules and their ions: H_2, H_2^+, He_2^+, Li_2, Be_2, B_2, C_2, N_2, O_2, O_2^+, O_2^-, O_2^{2-}, F_2, Ne_2 - Bond order and existence of molecule, energy (β) and magnetic behavior. M.O. energy level diagram, for heteronuclear diatomic molecules/ions like CO, NO, NO^+, HCl, HF and heteronuclear triatomic molecules/ions like H_3^+ (3c-2e), BeH_2, CO_2, NO_2. Molecular Orbital Theory of Coordination Complexes - 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 (sigma bonding only).	**12**

II	**Crystal Field Theory** 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, for octahedral (weak and strong field) and tetrahedral complexes with d^1 to d^{10} metal ion configurations. Evidence for CFSE - effect of crystal field splitting on i) Ionic radius and ii) Lattice energy. 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, Nephelauxetic effect and Nephelauxetic series, Limitations of CFT, modified CFT (LFT), Problems related to calculation of 10 Dq, CFSE and spin only magnetic moment for octahedral, tetrahedral & square planar complexes (i.e. for high spin & low spin complexes).	**12**
III	**Molecular Symmetry** Introduction and importance of molecular symmetry. Symmetry elements and symmetry operations (E, C_n, S_n, σ, i) with examples. Point Group concept and systematic identification of point groups in simple molecules according to symmetry elements present.	**06**
IV	**Organometallic Compounds** Definition and classification of organometallic compounds on the basis of bond type, 18-electron and 16-electron rules (MO Theory) with examples (carbonyls, nitrosyls, cyanides). Structures of mononuclear and binuclear carbonyls, pi-acceptor behaviour of CO, synergic effect. Hapticity (η) of organometallic ligands with examples. Metal-olefin complexes: Zeise's salt (preparation, structure and bonding). Ferrocene (preparation and structure).	**06**

References:

1. Concise Inorganic Chemistry by J.D. Lee - 5th Edition.
2. Inorganic Chemistry - D.F. Shiver & P.W. Atkins - C.H. Longford ELBS 2nd Edition.
3. Basic Inorganic Chemistry - F.A. Cotton and G. Wilkinson, Wiley Eastern Ltd 1992.
4. Concept and Model of Inorganic Chemistry by Douglas - Mc Daniels - 3rd Edition.
5. New Guide to Modern Valence Theory by G.I. Brown - 3rd Edition.
6. Coordination Chemistry by A. K. De.
7. Chemical application to Symmetry and Group theory - F. A. Cotton
8. Inorganic Chemistry by A. G. Sharpe - 3rd Edition.

T. Y. B. Sc. Chemistry Semester 5		
Title of the Course and Course Code	**Organic Chemistry I (CHE3503)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Summarize reaction types and mechanism of organic reactions. Recall the concepts of stereochemistry.	
CO2	Interpret reaction mechanisms involved in ester hydrolysis, amide hydrolysis, Sandmeyer reaction, condensation reaction, epoxidation reaction, free radical, photochemistry, cycloaddition reactions, explain Nucleophilic addition reactions including mechanisms and their selectivities.	
CO3	Apply Woodward Hoffmann rules to electrolytic and cycloaddition reactions. Solve nucleophilic addition, C-C coupling and aromatic substitution reactions with given reaction conditions.	
CO4	Distinguish the type of C-C coupling reactions and nucleophilic reactions.	
CO5	Prioritize the stereochemical outcome of electrocyclic and cycloaddition reactions. Determine the reaction mechanism in general from a theoretical perspective. Justify the major and minor product and its reaction mechanism.	
CO6	Create the green chemistry methods for practical implementation. Design the molecules with bridge structure with desired functionalities.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Reaction Mechanism** Representation of reaction mechanism using conventional tools, reaction mechanism involved in Ester hydrolysis, Amide hydrolysis, Aromatic nucleophilic substitution (Sandmeyer reaction, benzyne: formation and reactions), Condensation reactions, Epoxidation reactions (sulphur ylides, peracids), C-C Coupling reactions, Neighbouring group participation reactions.	**10**
II	**Nucleophilic addition to carbonyl group** Types of addition reactions: direct and conjugate addition, Regioselectivity and Chemoselectivity, Michael addition and Retro Michael reaction, Enamine reaction, Wittig reaction, Reformatsky reaction, Organomagnesium, Organocopper, Organolithium.	**8**
III	**Introduction to free-radicals, Photochemistry and Pericyclic reactions** Hybridization, stability and reactions of free-radicals. Principles of photochemistry, initiators and sensitizers, photochemistry of olefines and carbonyl compounds, photo rearrangements of 1,4-dienes (di-π methane), Norrish I, Norrish II type cleavage. Types pericyclic reactions, thermo and photocatalytic cycloaddition reactions, Woodward Hofmann rules and regioselectivity.	**12**
IV	**Green chemistry** Principles and significance of green chemistry, role of Ultrasound, microwaves and ionic liquids in chemical reactions.	**6**

References:

1. Advanced Organic Chemistry (Part A & B) - A. Carey and R. J. Sundberg.
2. Mechanism and Structure in Organic Chemistry - E.S. Gould.
3. Organic Chemistry by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford)
4. Modern Methods of Organic Synthesis by Carruthers and Iain Coldham
5. Organic Chemistry by Morrison and Boyd 6th Edn.
6. Organic Chemistry by Graham Solomans.
7. Organic Chemistry by I. L. Finar Vol. II Vth Edn.
8. Organic chemistry - by Cram, Hammond, Pine and Handrickson.
9. Photochemistry and Pericyclic reactions - Jagdamba Singh, Jaya Singh 3rd Ed.
10. Organic Photochemistry: A visual Approach - Jan Kopecky, VCH publishers (1992).
11. Stereochemistry of Organic Compounds, Principles and application by D. Nasipuri.
12. Stereochemistry conformations and mechanism by P. S. Kalsi.
13. Green Chemistry by V. K. Ahluwalia.

T. Y. B. Sc. Chemistry Semester 5		
Title of the Course and Course Code	**Analytical Chemistry I (CHE3504)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall the basic concepts and terminologies learned in topics like ionic equilibrium (concepts like common ion effect, α, pK_a, K_{sp}), spectrophotometry, and define basic laws (like Beer's law), learn equations like Ilkovic equations.	
CO2	a) Learn and explain the newer concepts (like homogeneous precipitation, post precipitation, half wave potential, spectrophotometric titrations etc.) in Gravimetric analysis, polarography, and spectrophotometry by extending the basic concepts learnt previously. b) Compare the different thermogravimetric techniques by relating the changes measured / observed in physical characteristics w. r. t. temperature changes. c) Explain the construction and working of analytical instruments like TGA, DTA, polarograph, single and double beam spectrophotometer, AAS, FES including various components like light source (HC lamp), detectors, read out systems in them.	
CO3	a) Understand and select the analytical technique available and make use of fundamental laws, equations, formulae based on application of theoretical concept involved therein, for qualitative and quantitative estimation of various chemical species. b) Solve numerical problems based on interpretation of the graphical and numerical data obtained from the analytical instrument so as to comment on the choice of the analytical technique. c) Identify the factors affecting the qualitative and quantitative analysis in each of the technique learnt.	
CO4	Compare the various analytical techniques like AAS, FES w. r. t. advantages and disadvantages of each technique and draw a conclusion so as to select a proper analytical technique for estimation of chemical species under investigation.	
CO5	Choose proper analytical techniques to estimate/determine quality and quantity of chemical species under investigation and draw a conclusion by study of the various results interpreted in the form of graphs, charts obtained from the analytical instruments.	
CO6	Read and execute the procedures for QC and QA process and review the quality documents.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Gravimetric Analysis** Common ion effect and solubility product principles, Conditions for good precipitation, Factors affecting precipitation like acid, temperature, nature of solvent, Supersaturation 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.	**8**
II	**Thermal Methods of Analysis** Principle of thermal analysis, classification of thermal techniques, Principle, instrumentation and applications of TGA and DTA, factors affecting the thermal analysis, numerical problems.	**6**
III	**Spectrophotometry** 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.	**8**
IV	**Polarography** Introduction to voltametric 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	6
V	**Atomic Absorption Spectroscopy** 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	**4**
VI	**Flame Emission Spectroscopy** 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.	**4**

References:

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

T. Y. B. Sc. Chemistry Semester 5		
Title of the Course and Course Code	**Industrial Chemistry I (CHE3505)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	List the importance of Chemical industry products, define the basic concepts, terminologies and recall reactions learned in chemical industries.	
CO2	Explain the basic requirements, general terms, processes of chemical industries and demonstrate the step and reactions involved in it.	
CO3	Apply the knowledge and explain application of various soap products and examine the MSDS and safety measures of hazardous chemicals.	
CO4	Classify and compare use of additives, builders, grades of alcohols by relating their chemical compositions and applications.	
CO5	Conclude the reasons for different observations and facts and explain the principle involved in the manufacturing process of chemical industry products, estimation of cane sugar.	
CO6	Plan and discuss the manufacturing process of industry products with flow-sheets diagrams and prepare the study report.	

Unit No.	**Title of Unit and Contents**	**No. of Lectures**
I	**Modern Approach to Chemical Industry** Introduction, Basic requirements of chemical industries, Chemical production, Raw materials, Unit process, Unit operation, Quality control, Quality assurance, Process control, Research and Development, Pollution control, Human resource, Safety measures, Conversion, Selectivity and Yield, Introduction to Copyright act, Patent act, Trademarks, MSDS. MSDS of hazardous chemicals (Benzene, Chloroform, Phenol).	**06**
II	**Manufacture of basic chemicals** **a. Ammonia:** Manufacture of NH_3 by Modified Haber - Bosch process, Physico - chemical principles involved, uses of NH_3. **b. Sulphuric acid:** Manufacture of H_2SO_4 by Contact process, Physico-chemical principles involved, uses of H_2SO_4. **c. Nitric acid:** Manufacture of HNO_3 by Ostwald`s process, Physico - chemical principles involved, uses of HNO_3.	**08**

III	**Soaps and detergents** **a. Soap industry:** Introduction, Importance, Raw materials for soaps, Manufacture soap, Special soap products, Toilet soap, Superfatted soap, Transparent soap, Medicated soap, Shaving soap and shaving cream, Cleansing powders**,** Washing action of soap. **b. Detergent industry:** Meaning of the terms - Detergent, Surfactants, Emulsion and Emulsifying agents, Wetting and Non-wetting, Hydrophobic and Hydrophilic nature, Amphipathic structures, Types of surfactants, Raw materials for detergents, Detergent builders, Additives, Manufacture of detergents, Washing action of detergents.	**08**
IV	**Sugar Industry** Introduction, Importance of Sugar industry, Manufacture of cane sugar: Raw material, Extraction, Clarification and Concentration of cane juice, Crystallization of sucrose, Centrifugation. Utilization of by-products of sugar industries, Testing and Estimation cane sugar.	**08**
V	**Fermentation Industry** Introduction, Importance, Basic requirement of fermentation process, Factors favoring fermentation, Fermentation operations. Manufacture of Industrial alcohol (Ethyl alcohol) from a) Molasses b) Food grains, c) Fruits. Grades of alcohol: Silence spirit, Rectified spirit, Absolute alcohol, Proof spirit, Denatured spirit, Duty and Duty - free alcohol. Importance of Power alcohol as fuel.	**06**

References:

1. Industrial Chemistry - B. K. Sharma, Goyal Publishing House, Mirut
2. Shreeve's Chemical Process Industries 5th Edition, G. T. Oustin, Mc Graw Hill
3. Riegel's Handbook of Industrial Chemistry, 9th Edition, Jems A. Kent
4. Industrial Chemistry - R. K. Das, 2nd Edition,1976.

Websites:

1. www.wikipedia.org/wiki/copyright_act_of1976
2. www.wikipedia.org/wiki/patent act
3. www.wikipedia.org/wiki/trademark
4. https://www.ccohs.ca/oshanswers/legisl/msdss.html

T. Y. B. Sc. Chemistry Semester 5		
Title of the Course and Course Code	**Biochemistry I (CHE3506)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Identify and label parts of a cell. Define, recall the structures of biomolecules and its significance.	
CO2	Classify biomolecules, compare and contrast its features and justify their properties related to biological function.	
CO3	Apply the concepts of biosignalling and immunity to understand the types of drugs and their mode of action.	
CO4	Analyse the interrelationship between biomolecules and distinguish between the hierarchy in their structures.	
CO5	Explain in vitro and in vivo reactions of biomolecules along with their significance.	
CO6	Plan the use of suitable methodologies and reagents for qualitative, quantitative analysis and purification of biomolecules.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Basic concepts of molecular logic of life** The chemical unity of diverse living organisms, composition of living matter, Macromolecules and their monomeric subunits. Unicellular and multicellular organisms, prokaryotes and eukaryotes. List of cell organelles and its functions.	**3**
II	**Carbohydrates** Definition, Biological significance, Classification with examples: Monosaccharides, Cyclisation of sugars by Fischer and Haworth projection formulas. Anomers, Epimers, reducing and non-reducing sugars, mutarotation, inversion. Reactions of glucose with acid, base, phenylhydrazine, oxidizing agents, reducing agents and its significance, glycosidic bonds. Structure and features of disaccharides, homo and heteropolysaccharides.	**6**
III	**Lipids** Definition, Biological significance, Classification-Simple, compound, steroids, derived lipids and their structures. Amphipathic lipids and their behaviour in water. Saponification number, acid number, iodine number and their significance. Rancidity. Types of Lipoproteins and their significance. Blood group substances. Prostaglandins.	**5**
IV	**Amino acids and Proteins** Amino acids: Structure of standard and nonstandard amino acids, classification of amino acids based on R group, nutrition, polarity. Ampholytes, Isoelectric pH, zwitter ions, titration curve of glycine. Reactions of amino acid with Ninhydrin, Sanger's, Dansyl chloride, Dabsyl chloride and Edmann's reagents and their significance. Peptide bond and its features.	**9**

	Proteins: Classification based on function, nutrition and composition. Overview of hierarchy in structural organization of proteins- primary, secondary, tertiary and quaternary structures.	
V	**Enzymes** Classification of enzymes. Apoenzyme, Prosthetic groups (coenzymes and cofactors) and Holoenzyme. Features of active site. ES complex formation, Enzyme specificity, Factors affecting enzyme activity. Basics of Enzyme kinetics. Significance of Km. Types of Enzyme inhibitions. Industrial uses of enzymes.	**5**
VI	**Basics of Medicinal Chemistry** Types of drugs - Antibacterial, Antiviral, Antifungal, Analgesics, Anaesthetics, CNS stimulants and depressants, Neurotransmitters. Medicinal role of competitive enzyme inhibitors. Types of Immunity. Overview of Signal Transduction. Types of receptors. Classification of hormones and their general mechanism of action.	**5**
VII	**Basics of Bioanalytical Techniques** Basic analytical techniques used for qualitative and quantitative estimation of biomolecules. Desalting of macromolecules by dialysis. Separation and purification of biomolecules by chromatography. Principle involved in lyophilisation.	**3**

References:

1. Lehninger, Principles of Biochemistry, by Nelson and Cox Macmillan Publisher fourth edition.
2. Biochemistry by U. Satyanarayana
3. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by Verma and Agarwal, 14th edition.
4. Biophysical Techniques by Upadhyay and Nath, 3rd revised edition.
5. Textbook of Microbiology - R. Ananthnarayan and C. K. J. Paniker
6. Biochemistry by West and Todd
7. Biochemistry by J. L. Jain
8. Biochemistry by Conn & Stumph
9. Medicinal Chemistry by Sriram / Yogeeswari
10. Medicinal Chemistry by Ashutosh Kar
11. Textbook of Medicinal Chemistry by Alagarsamy

T. Y. B. Sc. Chemistry Semester 5		
Title of the Course and Course Code	**Physical Chemistry Practical I (CHE3507)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Outline the instrumental and non - instrumental experiments by studying lab hand - outs to perform Physico - chemical experiments	
CO2	Compute and prepare the standard solutions, Carry out the calibration pH-meter, potentiometer, conductometer, colorimeter and refractometer. Operate these instruments and analyse the data.	
CO3	Determine the quantitative and qualitative analysis using pH-meter, potentiometer, conductometer, colorimeter, refractometer and critical solution temperature.	
CO4	Validate the Lamberts Beer's law. Interpret the spectra and evaluate the properties of molecules.	
CO5	Measure the rate constant, order and half period of the reaction by applying chemical kinetics.	
CO6	Design the experiment for the analysis of samples.	

Sr. No.	List of Practicals	Practical (hrs.)
I	**Phenol-water system** To study the effect of addition of salt on critical solution temperature of phenol-water System	**4**
II	**Colorimetry (Any one)** 1. Determination of λ_{max} and concentration of unknown solution of $KMnO_4$ in 2N H_2SO_4. 2. Determination of λ_{max} and concentration of unknown solution of Cu-NH_3 complex	**4**
III	**Potentiometry (Any two)** 1. To prepare standard 0.2 M Na_2HPO_4 and 0.1 M Citric acid solutions, hence prepare four different buffer solutions using them. Determine the pH values of these and unknown given solutions. 2. Determine the standard oxidation potential of the metal metal-ion electrode by using a secondary standard calomel electrode. 3. To determine the concentrations of strong acid and weak acid present in the mixture by titrating with strong base. 4. To determine the dissociation constant of dibasic acid potentiometrically.	**8**
IV	**pH metry (Any one)** 1. To determine the degree of hydrolysis of aniline hydrochloride. 2. To determine the dissociation constant of oxalic acid by pH-metric titration with strong base.	**4**

V	**Conductometry (Any one)** 1. To investigate the conductometric titration of (a) Strong acid against strong base and (b) Weak acid against strong base. 2. To estimate the amount of lead present in a given solution of lead nitrate by conductometric titration with sodium sulphate	**4**
VI	**Refractometry (Any one)** 1. To determine the molecular refractivity of the given liquids A, B, C and D. 2. To determine the specific refractivity of the given liquids A and B and their mixture and hence determine the percentage composition of their mixture C.	**4**
VII	**Chemical Kinetics (Any two)** 1. To study the effect of concentration of the reactants on the rate of hydrolysis of an ester. 2. To determine the order of reaction between $K_2S_2O_8$ and KI by half-life method. 3. Determine the rate constant of reaction between potassium persulphate and potassium iodide for equal concentration of the reactants (a=b). 4. To compare the relative strength of HCl and H_2SO_4 by studying the kinetics of Inversion of cane sugar using Polarimeter.	**8**
VIII	**Interpretation of spectra.** 1. Rotational spectra of diatomic molecules CO / HCl / DCl. 2. Rotational spectra of triatomic molecules CO_2 / HCN. 3. Rotational - Raman spectra of diatomic molecules.	**4**

References:

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

T. Y. B. Sc. Chemistry Semester 5		
Title of the Course and Course Code	**Inorganic Chemistry Practical I (CHE3508)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recapitulate the fundamentals of mole concepts. Comprehend the basic principles of volumetric and complexometric analysis.	
CO2	Explain the reason for the formation of coordinate complexes.	
CO3	Synthesize, analyze and interpret the color and magnetic properties of the complexes.	
CO4	Understand the procedure and calculate the amount, yield and percentage purity.	
CO5	Determine the concentration of metals ions by complexometrically.	
CO6	Conclude and compile the result.	

Sr. No.	List of Practicals (Any Ten Experiments)	Practical (hrs.)
I	**Volumetric Estimations (Any Four)** 1. Estimation of Mn by Volhard's method. 2. Estimation of NO_2^- by using $KMnO_4$. 3. Estimation of copper by Iodometry (from brass or coordination complex). 4. Fertilizer analysis (PO_4^{3-}). 5. Determination of magnesium from commercial sample of milk of magnesia tablet. 6. Estimation of amount of iron and oxalic present in potassium tris (oxalate) ferrate(III). 7. Estimation of Fe(III) and Mn(II) in a mixture using standardized $KMnO_4$ solution. 8. Estimation of Fe(III) and Cu(II) in a mixture using $K_2Cr_2O_7$.	**16**
II	**Complexometric Estimations (Any Two)** 1. Estimation of Nickel(II) complexometrically using murexide indicator 2. Estimation of Zinc(II) complexometrically. 3. Estimation of Ca(II) and Mg(II) in a mixture complexometrically.	**8**
III	**Inorganic preparations - Comment on color and Magnetic properties of the complexes (Any four)** 1. Potassiumtrioxalatoferrate(III), $K_3[Fe(C_2O_4)_3]$. 2. Trisacetylacetonatoiron(III), $[Fe(acac)_3]$. 3. Potassiumtrioxalatoaluminate(III), $K_3[Al(C_2O_4)_3]$.. 4. Manganese(III)acetylacetonate, $[Mn(acac)_3]$. 5. Tris(thiourea)copper(I)chloride, $[Cu(tu)_3]Cl$. 6. Potassiumdiaquabis-(oxalate)cuprate(II), $K_2[Cu(C_2O_4)_2.(H_2O)_2]$. 7. Tris(ethylenediamine)nickel(II)chloride, $[Ni(en)_3]Cl_2$. 8. Bis(acetylacetonato)copper(II), $[Cu(acac)_2]$.	**16**

References:

1. Analytical Chemistry by G. D. Christian 6th Edition.
2. Vogel's Textbook of Quantitative Chemical Analysis 6th Edition by R. C. D. Denney, J. D. Barnes, M. J. K. Thomas.
3. Handbook of Preparative Inorganic Chemistry, Volume 2, Second Edition, Edited by George Braue R, Academic Press, 1965.
4. Inorganic Synthesis, Vol-I by H S Booth, First Edn, 1939.
5. Journal of Chemical Education, 1983, 60 (11).
6. Journal of Chemical Education, 1999, 79 (09).
7. Journal of Chemical Education, 1971, 48 (2), 133.

T. Y. B. Sc. Chemistry Semester 5		
Title of the Course and Course Code	**Organic Chemistry Practical I (CHE3509)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Define the basic terms in organic qualitative, quantitative analysis. Recall the types of volumetric analysis and purification techniques.	
CO2	Explain the reactions involved in organic qualitative analysis, volumetric estimations, organic preparations. Carry out the separation of binary organic mixture [(solid + solid)] followed by elemental analysis, functional group detection and physical constant of individual component.	
CO3	Identify and apply the appropriate solvent system for purification (crystallization) and Thin Layer chromatography techniques to distinguish the product in organic synthesis.	
CO4	Examine the tests, observations to infer structural formula of unknown organic compounds and quantification of organic substances by volumetric analysis.	
CO5	Interpret and explain the results of organic qualitative analysis of unknown binary mixture [(Solid + Solid)], volumetric analysis. Justify product of organic synthesis by comparing different spectrophotometric data.	
CO6	Predict and compile the results of qualitative, quantitative analysis and organic synthesis. Develop skills required in chemistry such as proper handling of apparatus and chemicals.	

Sr. No.	**List of Practicals (Minimum 10 Experiments)**	**Practical (hrs.)**
I	**Organic Qualitative analysis of Binary mixture (S+S)** **[Minimum 4 mixtures]** 1. Determination of Nature, Type of the mixture. 2. Separation of the mixture into two components. 3. Purification of the component. 4. Individual analysis of the compound a. Preliminary Test, b. To determine physical constant, c. To determine elements, d. To determine functional group.	**16**

II	**Organic Estimations [Any 2]** 1. Estimation of acetone, 2. Estimation of acetamide, 3. Estimation of glucose, 4. Estimation of acid value of the given oil.	**8**
III	**Organic Preparations [Any 4]** 1. Preparation of β-naphthyl methyl ether from β-naphthol. 2. Preparation of dibenzylidene acetone from acetone. 3. Preparation of benzimidazole from o-phenylenediamine. 4. Preparation of benzylic acid from benzil. 5. Preparation of 2, 4-dinitrophenyl hydrozone derivative of aldehyde / ketone. 6. Green synthesis of 4-nitro-2-hydroxy benzoic acid using Calcium nitrate. 7. Green synthesis of benzhydrol from benzophenone. 8. Green synthesis of acetanilide from aniline using Zn / acetic acid. 9. Preparation of 2, 4-dinitro phenol from 2,4-dinitro chloro benzene. 10. Preparation of adduct of maleic anhydride and anthracene (Diel's Alder).	**16**

References:

1. Practical Organic Chemistry by - A. I. Vogel.
2. Practical Organic Chemistry by - O. P. Agarwal.

T. Y. B. Sc. Chemistry Semester 5		
Title of the Course and Course Code	**Chemical Lab Safety and Waste Management (CHE3511)**	**Number of Credits: 0**2
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Outline and understand the principles of chemical toxicology and safety in laboratory.	
CO2	Interpret the safety data sheets to categorise chemicals according to their hazards.	
CO3	Classify, illustrate and implement the methods to manage hazards.	
CO4	Compare and integrate the methods to handle chemical waste.	
CO5	Apprise the safety measures and apply to chemical waste management.	
CO6	Identify, modify and construct a plan for safe laboratory operations and waste management.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Principles, Ethics and Practices** Introduction and importance of laboratory safety, Four Principles of safety-RAMP, Hazards in different Labs, The Student Safety Ethics, Safety rules, Role as a Student, Critical analysis of Lab incidents (include reactions), Green Chemistry alternatives to conventional methods in labs and industries, The Twelve Principles of Green Chemistry and Sustainability.	**6**

II	**Understanding and Communicating Laboratory Hazards** Potential pathways of exposure and blocking these pathways to prevent exposure, Hazard recognition through the basics of understanding labels, signs, symbols, terms, and other sources of information, Material Safety Data Sheets (MSDS), Safe Handling Precautions, Interpreting MSDS Information, overview of GHS Safety Data Sheets and GHS labelling Project work: Creation of MSDS / GHS Safety Data sheets	**5**
III	**Laboratory Hazards: Toxic Substances and Biological Agents** Types of hazards, Chemical Hazards: corrosive acids, bases, gases, oxidizers, flammables, fire triangle, water reactive compounds, pyrophoric chemicals and reactions (Grignard's reaction), peroxides, cryogens, catalysts. Radiation Hazards: ionizing, nonionizing radiations and electric and magnetic field. Introduction to Toxicology: Basic principles of toxicology, Structure - Activity Relationships, Factors Influence Toxicity, Acute and Chronic Toxicity, Mercury toxicity, Carcinogens, Mutagens, Biological Hazards and Biosafety - hazards of biological agents and some general approaches to prevent exposures. Experimental Session / Case Study: Radiation Hazards, Metal Toxicity	**8**
IV	**Response to Lab incidences** Response to chemical spills (acids, bases and other chemicals) and fire, Classes of Fires and Types of Fire Extinguishers (and demonstration), First aid in chemical lab, emergency safety equipment. Demonstration: Fire Extinguishers Experimental Session / Case Study: Response to chemical spills	**5**
V	**Handling chemicals and Minimizing hazards in laboratory** Introduction to handling hazardous chemical waste, storing flammable and corrosive liquids, maintaining a safe and secure laboratory, managing chemicals in laboratory. Safety measures for common laboratory operations. Managing risk-decision about safety, eye and face, skin protection-clothes, gloves and tools, chemical hoods, contamination and ventilation, safety measures for common laboratory operations, radiation, laser and biological safety cabinets. Experimental Session / Case Study: Risk Management	**7**
VI	**Chemical waste management in Industries** Chemical Industry Waste management, Disposal Measures: Waste Combustion, Landfill Disposal of Wastes, Asbestos Disposal, Utilization of Product Wastes: Plastics Recycling, Zero Waste: Concept and Practice. **Seminar / Project / Case study / Research Paper Review / Industrial Visit and report (wherever applicable in all the units)**	**5**

References:

1. Laboratory safety for chemistry students, second edition, Robert H. Hill, Jr. David C. Finster**,** John Wiley & Sons.
2. Solid Waste Management, Principles and Practice, Ramesha Chandrappa, Diganta Bhusan Das, Springer.
3. Production-Integrated Environmental Protection and Waste Management in the Chemical Industry, Claus Christ, WILEY-VCH.

4. Fundamentals of Industrial Safety and Health, Dr. K. U. Mistry, Siddharth Prakashan.
5. Hazardous Waste Management Rules - 2016, 1st editon, Ministry of Environment, Forest & Climate Change, Govt. of India.

T. Y. B. Sc. Chemistry Semester 5		
Title of the Course and Course Code	**Pharmacology (CHE3512)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Identify and describe the pharmacological actions of different categories of drugs	
CO2	Understand the detailed mechanism of drug action at organ system / sub cellular / macromolecular levels	
CO3	Examine and apply the basic pharmacological knowledge in the prevention and treatment of various diseases.	
CO4	Compare and differentiate pharmacology with other biomedical sciences.	
CO5	Determine signal transduction mechanism of various receptors	
CO6	Rearrange the drugs according to their mechanism of action.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Pharmacology, scope of Pharmacology** Routes of administration of drugs, their advantages and disadvantages. Various processes of absorption of drugs and the factors affecting them, Metabolism, distribution and excretion of drugs General mechanism of drugs action and the factors which modify drug action	**9**
II	**Pharmacological classification of Drugs** The discussion of drugs should emphasize the following aspect: Drugs acting on the Central Nervous System: (a) General anesthetics, adjunction to anesthesia, intravenous anesthetics. (b) Analgesic antipyretics and non-steroidal anti - inflammatory drugs, Narcotic analgesics, Antirheumatic and antigout remedies, Sedatives and Hypnotics, Psychopharmacological agents, anticonvulsants, analeptics	**6**
III	**Drugs acting on the respiratory system** Respiratory stimulants, Bronchodilators, Nasal decongestants, Expectorants and Antitussive agents.	**10**
IV	Cardiovascular drugs, Cardiotonics, Antiarrhythmic agents, Antianginal agents, Antihypertensive agents, Peripheral Vasodilators and drugs used in atherosclerosis. Chemotherapy of cancer	**5**

PRACTICALS (Any Six)

S. N.	Topics	Lectures
1	To Prepare, Evaluate and submit compound Benzoin Tincture I. P	1
2	To Prepare, Evaluate and submit Cold Cream.	1
3	To Prepare, Evaluate and submit calamine lotion I. P	1
4	To Prepare, Evaluate and submit clear Shampoo	1
5	To Prepare, Evaluate and submit Toothpaste	1
6	To Prepare, Evaluate and submit hair grooming Gel	1
7	To Prepare, Evaluate and submit Lipstick.	1
8	To Prepare, Evaluate and submit sterile water I. P.	1
9	To Prepare, Evaluate and submit Orange Spirit B. P	1
10	To Prepare, Evaluate and submit Peppermint Spirit.	1

References:

1. Barar F S K., Text Book of Pharmacology, Interprint, new Delhi.
2. Crossland J and Thomson J H., Essentials of Pharmacology, Harper and Row Publishers NY
3. Goodman and Gilman's, The Pharmacological basis of Therapeutics; Editors: J. G. Hardman, L. E. Limbird, P. B. Molinoss, R. W. Ruddon and A. G. Gil, Pergamon Press.".
4. Katzung, B. G., Basic and Clinical Pharmacology, Prentice Hall, International.
5. Paul L., Principles of Pharmacology, Chapman and Hall.
6. T'heoharides T. C., Pharmacology, Little Brown and Co.

T. Y. B. Sc. Chemistry Semester 6		
Title of the Course and Course Code	**Physical Chemistry II (CHE3601)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Recall and describe the fundamentals of Nuclear chemistry, Chemical kinetics, and electrolytic conductance.	
CO2	Compare the properties and penetrating power of nuclear radiations. Classify and analyse various types of nuclear processes and specify the type of counters used for measurement of radioactivity.	
CO3	Explain the basic concepts and theories of conductance. Apply the electrical conductance to study ionic product, solubility and conductometric titration	
CO4	Interpret the equations of chemical kinetics for third order reactions with their characteristic properties.	
CO5	Calculate the degree of freedom of the different systems based on Gibb's phase rule and interpret the phase diagrams. Validate the Freundlich and Langmuir adsorption isotherms.	
CO6	Solve the numerical based on Chemical kinetics, Nuclear chemistry, Electrolysis and electrical conductance.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Chemical Kinetics** Recapitulation of chemical kinetics, Third order reaction of 3 types (i) 3A $\longrightarrow$ Products (ii) A+2B $\longrightarrow$ Products (iii) A+B+C $\longrightarrow$ Products. Differential rate laws for (i), (ii) and (iii) derivation of integrated rate law for third order reaction with equal initial concentration [for (i)], characteristics of third order reaction. Effect of temperature on the rate of reaction.	**6**
II	**Nuclear Chemistry** 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, types of nuclear reaction, measurements of radioactivity, gaseous ion collection method, proportional, G.M. and Scintillation counters. Applications of radioactivity - radiochemical principles in the use of tracers, typical applications of radioisotopes as a tracer a. Chemical investigations - reaction mechanism b. Structure determination - phosphorus pentachloride and thiosulphate c. Age determination - by Carbon-14 dating and Uranium Lead / Thorium - Lead Ratio d. Medical applications - Assess the volume of blood in patient's body, Goitre	**10**
III	**Electrical Conductance** Electrolytic conductance, specific, equivalent and molar conductance, variation of equivalent conductance with concentration, Kohlrausch's law and its applications to determine	**10**

	equivalent conductance at infinite dilution of a weak electrolyte. Transport number, determination of transport number by Hittorf's method and moving boundary method. Inter ionic theory of conductance, Debye-Huckel-Onsager equation and its validity, absolute velocity of ions. Application of conductance measurement: ionic product of water, solubility of sparingly soluble salts, conductometric titrations. Activity in solution, fugacity and activity coefficient of strong electrolyte.	
IV	**Phase Rule** Meaning of Phase, components and degree of freedom with examples, Definitions, Gibb's phase rule, one component system (moderate pressure only) for sulphur and water system, two component systems for silver-lead and zinc-cadmium.	**6**
V	**Adsorption** Adsorption phenomenon, Adsorption of gases by solids, Types of adsorption, Freundlich and Langmuir adsorption isotherms, adsorption of solute by solids, types of adsorptions (Physical & Chemical). BET equation (no derivation), determination of surface area using Langmuir and BET equations.	**4**

References:

1. Principles of Physical Chemistry, Fourth Edition by S. H. Maron and C. F. Prutton
2. Essentials of Nuclear Chemistry by H. J. Arnikar
3. Elements of physical Chemistry by Atkins and Paula, fifth edition 2009 (Indian Edition)
4. Principle of Physical chemistry by Puri Sharma Pathania
5. Source book of Atomic energy by Glasstone
6. Chemical Kinetics by Laidler

T. Y. B. Sc. Chemistry Semester 6		
Title of the Course and Course Code	**Inorganic Chemistry II (CHE3602)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Name and classify elements in f-block, report oxidation states, properties and application.	
CO2	Describe electronic states, term symbols and spin-orbit coupling. Determine terms and construct microstate table of polyelectronic transition metal ions.	
CO3	State and clarify the rules for electronic transitions and apply to interpret visible electronic absorption spectra.	
CO4	Categorize solids on the basis of bonding. Predict the structural arrangement in lattices. Calculate ionic radii and solve numericals. Interpret Born Haber cycle and its applications.	
CO5	Analyze and solve the problems.	
CO6	Recapitulate the roles of metals in bioinorganic chemistry. Classify and explain function of enzymatic and non-enzymatic metals. Exemplify structure and function of important metallo-proteins.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Chemistry of f-block elements** Introduction of f-block elements- on the basis of electronic configurations, occurrence and reactivity. The shapes of *f*-orbitals. **Lanthanides -** Position in periodic table, Name and electronic configuration of lanthanides, Chemistry of lanthanides with reference to (i) lanthanide contraction, (ii) Oxidation states (iii) magnetic and spectral properties, and (iv) separation (Group / Individual) by modern methods (ion exchange and solvent extraction method), applications of lanthanides. **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, applications of actinides. IUPAC nomenclature system for super heavy elements with atomic no. (z) greater than 100, Comparison between Lanthanides and Actinides.	**6**
II	**Electronic Spectra** Introduction: Electronic configuration, electronic states and terms for poly-electronic atoms, Term symbols, coupling of spin momenta (M_s), orbital momenta (M_l) and spin- orbit coupling or Russell-Saunders coupling. Determination of Terms for p^2 electronic configuration (as in a carbon atom). Terms and micro-states for transition metal atoms / ions. Types of electronic transitions like intra - ligand transitions, charge transfer transitions and intra-metal transitions and (*d-d* or ligand field transitions for transition metals). Rules for electronic transitions: Spin and Orbital or Laporte selection rules. Orgel Diagrams for D Terms (i.e, d^1, d^4 and d^6, d^9 electronic configurations) and its use in interpretation of visible electronic absorption spectra of these configurations. Charge Transfer Spectra - MLCT, LMCT (elementary ideas).	**12**
III	**Ionic Solids** Importance of solid-state chemistry. Classification of solids on the basis of bonding. Crystalline and amorphous solids, Closest packing of rigid spheres (hcp, ccp), Structures of sodium chloride and caesium chloride. Packing density in simple cubic, bcc, fcc and hcp lattices (numerical problems expected). Crystal structures simple cubic, body centered cubic and face centered cubic, Properties of ionic solids, packing arrangements of anions in an ionic solids, Voids in crystal structure- tetrahedral and octahedral, Ionic radius, Palings univalent and crystal radii, Conversion of univalent radii to crystal radii, problems based on conversion of radii, Radius ratio effect, calculation of limiting radius ratio Lattice energy, Born-Lande equation, Born Haber cycle and its applications, Point defects with respect to Frenkel and Schottky defects.	**10**

IV	**Bioinorganic Chemistry** Introduction, classification of elements according to their action in biological system, excess and deficiency of some trace metals. Role of metal ions (Na-/ K, Zn, Cu, Mg) present in biological systems - enzymatic and non-enzymatic processes. Iron and its application in bio-systems, Haemoglobin and Myoglobin - structure and functions. Fe-S electron transfer proteins. Bioinorganic Chemistry of Co: Vitamin-B_{12}, its structure and function.	**8**

References:

1. Concise Inorganic Chemistry by J. D. Lee - 5th Edition.
2. Inorganic Chemistry, - D. F. Shiver & P. W. Atkins - C. H. Longford ELBS - 2nd Edition.
3. Basic Inorganic Chemistry - F. A. Cotton and G. Wilkinson, Wiley Eastern Ltd. 1992.
4. Concept and Model of Inorganic Chemistry by Douglas - Mc Daniels - 3rd Edition.
5. Inorganic Chemistry by J. E. Huheey, 4th Edition, Pearson Education.
6. Inorganic Chemistry by A. G. Sharpe - 3rd Edition
7. Principles of Bioinorganic Chemistry by S. J. Lippard and J. M. Berg, 1st Edition.

T. Y. B. Sc. Chemistry Semester 6

Title of the Course and Course Code	**Organic Chemistry II (CHE3603)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall the functional groups in organic chemistry and the terms involved in retro synthesis. Choose the functional group with specific reactivity in organic reactions. Define the terms used in the UV, IR, ^{1}H NMR.	
CO2	Explain the principle involved in UV, IR, ^{1}H NMR and infer different phenomenon occurred in UV, IR, ^{1}H NMR.	
CO3	Solve the reaction mechanism involved in synthesis of natural products. Analyze the structure elucidation based on UV, IR, ^{1}H NMR.	
CO4	Compute the λ_{max} for the conjugated dienes, enone system and analyze the different observations in UV, IR, ^{1}H NMR.	
CO5	Examine the structure elucidation of terpenoids and alkaloids, estimate values of chemical shift, delta and Tau-scales, peak area, integration, spin-spin coupling, coupling constants, J-value. justify different observations in the UV, IR, ^{1}H NMR.	
CO6	Design the synthesis route for the given target molecule and imagine the retro synthesis for the given target molecule.	

Unit No.	**Title of Unit and Contents**	**No. of Lectures**
I	**Retrosynthesis** Different terms used, Disconnection, Synthons, Synthetic equivalence, FGI, TM. One group disconnection, Retrosynthesis and Synthesis of target molecules: Acetophenone, Crotonaldehyde, Cyclohexene, Benzylbenzoate, and Benzyl diethyl malonate.	**5**
II	**Natural Products** a) Terpenoids: Isolation, Classification. Citral - structure	**7**

	determination using chemical and spectral methods, Synthesis of Citral by Barbier and Bouveault Synthesis. b) Alkaloids: Extraction, Purification, Some examples of alkaloids and their natural resources. Ephedrine - structure determination using chemical methods. Synthesis of Ephedrine by Nagi.	
III	**UV Spectroscopy** Introduction, nature of UV, Beer's law, absorption of UV radiation by organic molecule leading to different excitation. Terms used in UV Spectroscopy-Chromophore, Auxochrome, Bathochromic shift (Red shift), hypsochromic shift (Blue shift), hyperchromic and hypochromic effect. Effect of conjugation on position of UV band. Calculation of λ_{max} by Woodward and Fisher rules for dienes and enone systems, Colour and visible spectrum, Applications of UV Spectroscopy - Determination of structure.	**6**
IV	**IR Spectroscopy** Principle of IR Spectroscopy, Fundamental modes of vibrations (3N-6, 3N-5) Types of vibrations (Stretching and bending), Hooks law, Condition for absorption of IR radiations, vibration of diatomic molecules. Regions of IR Spectrum: fundamental group region, fingerprint region, aromatic region, Characteristic of IR absorption of functional groups: Alkanes, alkenes, alkynes, alcohol, ethers, alkyl-halides, carbonyl compounds (-CHO, >C=O, -COOR, -COOH), amines, amides and Aromatic Compounds and their substitution Patterns. Factors affecting IR absorption: Inductive effect, resonance effect, hydrogen bonding. Application of IR Spectroscopy in determination of structure, chemical reaction and hydrogen bonding.	**6**
V	**^{1}H NMR Spectroscopy** Principles of PMR Spectroscopy, Magnetic and nonmagnetic nuclei, Precessional motion of nuclei without mathematical details, Nuclear resonance, chemical shift, shielding, & deshielding effect. Measurement of chemical shift, delta and Tau-scales. TMS as reference and its advantages, peak area, integration, spin-spin coupling, coupling constants, J-value (Only first order coupling be discussed). Problems of structure elucidation based on UV, IR, ^{1}H NMR.	**12**

References:

1. Designing Organic Synthesis by Stuart Warren 1983.
2. Organic Chemistry by Cram and Hammond.
3. Organic Chemistry by Clayden, Greeves, Warren and Wothers
4. Organic Chemistry by I. L. Finar Vol. II Vth Edn.
5. Introduction to Spectroscopy - D. L. Pavia, G. M. Lampman, G. S. Kriz, 3rd Ed. (Harcourt College Publishers).
6. Spectrometric identification of organic compounds R. M. Silverstein, F. X. Webster, 6th Ed. John Wiley and Sons.
7. Spectroscopic methods in organic chemistry - D. H. Williams and I. Flemming, McGraw Hill
8. Absorption spectroscopy of organic molecules - V. M. Parikh
9. Nuclear Magnetic Resonance - Basic Principles - Atta - Ur - Rehman, Springer - Verlag (1986).

T. Y. B. Sc. Chemistry Semester 6		
Title of the Course and Course Code	**Analytical Chemistry II (CHE3604)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	a) Get acquainted with the basic concept of solvent extraction and various terms in and factors affecting it. Recognise that various chromatographic techniques are the extension of the solvent extraction concept with the help of the Match - Box model. b) Learn the basic concepts, instrumentation in Mass spectrometry with the help of labelled diagrams.	
CO2	Enumerate, explain and differentiate various types of chromatographic and solvent extraction techniques and demonstrate construction and working of instruments used in them with the help of labelled diagrams.	
CO3	a) With the help of neat labelled diagrams learn the applied chromatographic techniques of Gas chromatography, HPLC with respect to their instrumentation, components therein and their applications. b) Extend the basic concept of electrochemistry and spectroscopy leant in previous level to understand the techniques, instrumentation of Electrophoresis, Nephelometry and Turbidimetry.	
CO4	Compare the similarities and differences between Nephelometry and Turbidimetry w. r. t. instrumentation which ultimately reflects in their applications.	
CO5	a) Apply various chromatographic techniques for qualitative and quantitative estimations of chemical species under investigation and draw a conclusion by study of the various results interpreted in the form of R_f values, graphs, charts obtained from the analytical instruments.	
CO6	Identify the role of various chromatographic, extraction techniques in the field of analysis and research.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**SolventExtraction** Introduction, Principle of solvent extraction, Distribution coefficient, distribution ratio, relation between Distribution coefficient and distribution ratio, factors affecting solvent extraction, percentage extracted, solvent extraction methods, 3504, separation factor, batch extraction, counter current extraction, application of solvent extraction, numerical problems.	**6**
II	**Chromatography** 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	**6**
III	**Gas Chromatography** Introduction, Theory, Principle, GSC and GLC, Separation mechanism involved in GSC and GLC, Instrumentation of Gas chromatography, Working of gas chromatography, Gas	**6**

	chromatogram and qualitative-quantitative analysis, Applications of gas chromatography	
IV	**High Performance Liquid Chromatography** Introduction, Need of liquid chromatography, Separation mechanism involved in adsorption and partition HPLC, Instrumentation and working of HPLC, Applications of HPLC, Introduction to supercritical fluid chromatography.	**6**
V	**Electrophoresis** 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.	**5**
VI	**Nephelometry and Turbidimetry** Introduction, Principles and instrumentation of nephelometric and turbidimetric analysis, difference between nephelometric and turbidimetric measurements, choice between nephelometry and turbidimetry, factors affecting nephelometric and turbidimetric measurements, quantitative applications, numerical problems.	**5**
VII	**Introduction to Mass Spectrometry** Mass Spectrometry: Basic principles, introduction of components only.	**2**

References:

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

T. Y. B. Sc. Chemistry Semester 6		
Title of the Course and Course Code	**Industrial Chemistry II (CHE3605)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	List the importance of chemical industry products, define the basic concepts, terminologies and recall reactions learned in chemical industries.	
CO2	Explain the general aspects of small-scale industries, general terms, processes chemical industries and demonstrate the steps, reactions involved in it.	
CO3	Apply the knowledge to describe manufacturing processes in small-scale industries and explain the synthesis of dyes and petrochemicals.	
CO4	Classify and compare use of different organic dyes, fertilizers, petrochemicals by relating their chemical compositions and applications.	
CO5	Conclude the reasons for different observations, facts and explain the types of glass, fertilizers, dyes and petrochemicals products.	
CO6	Plan and discuss in detail the manufacturing process of chemical industry products with flow-sheet diagrams and prepare the study report.	

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Glass industry** Introduction, Importance, Physical and Chemical properties of glass, Chemical reactions, Manufacture of glass using Tank furnace. Forming of glass: Pressing, Blowing, Drawing, Rolling. Annealing, Finishing, Grading and Gauging of glass articles. Special glasses: Coloured, Safety, Hard, Boro - Silicate, Optical, Conducting, Glass laminates.	**08**
II	**Fertilizer Industry** Introduction, Micronutrients, Importance of fertilizers, Organic manure, Vermi-compost, N, P, K ratio. Types of fertilizers. a. Nitrogenous fertilizers: Manufacture of Urea. b. Phosphatic fertilizers: Manufacture of Single and Triple super phosphate. c. Potash fertilizers. d. Mixed fertilizers: Manufacture of Mixed fertilizer.	**09**
III	**Dyes** Introduction, Importance, Qualities of good dye, Colour, Colour and Chemical constitution, Otto-Witt`s theory of colour, Resonance theory, Molecular approach to colour. Classification of dyes according to their applications. Meaning of terms: Chromophore, Auxochrome, Bathochromic (Red) and Hypsochromic (Blue) shift. Synthesis and Uses of following dyes: Methyl orange, Rosaniline, Crystal violet, Phenolphthalein, Fluorescein, Alizarin.	**06**
IV	**Petrochemicals and fuels** a) Introduction, Occurrence, Composition of petroleum, Refining of petroleum, Processing of petroleum, Cracking, Applications of petrochemicals, Synthetic petroleum, Lubricating oils, Additives. b) Fuels: Calorific value of fuel, Flash point, Octane rating (Octane number), Cetane number. Liquid fuel - Diesel, Bio-diesel, Gasoline. Gaseous fuel - LPG, CNG.	**09**

V	**Small Scale Industries** Introduction and Aspects of Small - Scale Industries, Safety Matches, Agarbattis, Naphthalene balls, Wax Candles, Shoe Polish, Gum Paste, Writing and fountain Pain ink, Plaster of Paris, How to Remove Stains.	**04**

References:

1. Industrial Chemistry - B. K. Sharma, Goyal Publishing House, Mirut
2. Shreve's Chemical Process Industries 5th Edition, G. T. Austin, McGraw Hill
3. Riegel's Handbook of Industrial Chemistry, 9th Edition, James A. Kent
4. Industrial chemistry - R. K. Das, 2nd Edition, 1976.
5. The Petroleum chemicals industry by R. F. Golds tine, e & Fn London
6. Fundamentals of petroleum chemical technology by P Belov.

T. Y. B. Sc. Chemistry Semester 6

Title of the Course and Course Code	**Biochemistry II (CHE3606)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall structures of nucleic acids, metabolic intermediates, and define terms related to molecular biology, biotechnology, bioinformatics and metabolism.	
CO2	Explain molecular mechanisms. Discuss the experimental basis that interprets features of nucleic acids. Outline the principle and methodology in characterisation of biomolecules and molecular docking.	
CO3	Apply knowledge of enzymology to understand formation of specific intermediates in biochemical pathways, drug action and outline the process of bioenergetics.	
CO4	Classify tools of genetic engineering according to their significance and apply the concepts in gene cloning.	
CO5	Justify varied conditions required for the occurrence of desired metabolic reactions. Compare the structural features of nucleic acids based on their functional significance.	
CO6	Assemble monomeric building blocks to synthesize polymeric structures. Rearrange the sequences of biochemical pathways Predict complementary sequences.	

Unit No.	**Title of Unit and Contents**	**No. of Lectures**
I	**Introduction to Metabolism** Types of metabolic reactions, High energy compounds, Significance of ATP.	**2**
II	**Carbohydrate Metabolism and TCA Cycle** Aerobic and anaerobic glycolysis, Fates of Pyruvate, TCA cycle with energetics. HMP Shunt and its significance.	**6**
III	**Lipid Metabolism** β-oxidation of palmitic acid in mitochondria with energetics. Triglyceride synthesis, Ketogenesis.	**3**
IV	**Amino Acid Metabolism** Transamination, deamination reactions of amino acids, Urea cycle.	**3**

	Biosynthesis of neurotransmitters from amino acid precursors.	
V	**Electron Transport Chain and Oxidative Phosphorylation** Electron transport chain, Proton gradient, Oxidative phosphorylation-Chemiosmotic hypothesis. Inhibitors and Uncouplers.	**2**
VI	**Nucleic Acids** Structures of Purines and Pyrimidines, Nucleosides, Nucleotides, Polynucleotides, Difference between DNA and RNA. Watson and Crick model of DNA. DNA as genetic material (Griffith, Avery, Macleod and Mcarty, Hershey and Chase experiments), RNA and its types.	**3**
VII	**Basics concepts of molecular mechanisms** Chemistry of DNA Replication-Semiconservative model of replication (Messelson and Stahl experiment), Brief account of initiation, elongation and termination of DNA replication in bacteria and enzymes involved. Mechanism of Transcription-Brief account of initiation, elongation and termination of transcription in bacteria and enzymes involved. Translation and Gene Regulation-Genetic code and its features. Brief account of initiation, elongation and termination of protein synthesis in bacteria, Lac operon.	**8**
VIII	**Introduction to Biotechnology** Basic tools of genetic engineering - Restriction endonucleases, vectors, chimera. Steps in insulin gene cloning.	**2**
IX	**Advanced concepts in Medicinal Chemistry** Types of toxins. Xenobiotic metabolism (Detoxification reactions). Mechanism of action of antibiotics that affect molecular processes. Anticancer drugs.	**4**
X	**Advanced Bioanalytical Techniques and Computational Biochemistry** Separation, purification and characterisation of biomolecules by gel electrophoresis. Computational Biochemistry - Introduction to Bioinformatic tools. Molecular Docking (any one drug / enzyme / molecule as example).	**3**

References:

1. Lehninger, Principles of Biochemistry, by Nelson and Cox Macmillan Publisher, 4th Edition.
2. Harper's Illustrated Biochemistry, 26th Edition.
3. Biochemistry by U. Satyanarayana
4. Biotechnology by U. Satyanarayana
5. Biophysical techniques by Upadhyay and Nath, 3rd revised edition
6. Medicinal Chemistry by Sriram / Yogeeswari
7. Medicinal Chemistry by Ashutosh Kar
8. Textbook of medicinal chemistry by Alagarsamy
9. Bioinformatics: Principles and Applications by Zhumur Ghosh, Bibekan and Mallick.

T. Y. B. Sc. Chemistry Semester 6		
Title of the Course and Course Code	**Physical Chemistry Practical II (CHE3607)**	**Number of Credits: 02**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	List and outline the instrumental and non - instrumental experiments.	
CO2	Calculate and prepare the standard solutions. Carry out the calibrations of, pH-meter, potentiometer, conductometer, colorimeter and refractometer. Operate the instruments and analyse the data.	
CO3	Determine the quantitative and qualitative analysis using pH-meter, potentiometer, conductometer, colorimeter, refractometer, transport number, viscometer.	
CO4	Test properties of radioactive particles using Geiger - Muller counter. Validate the Lamberts Beer's law, Freundlich and Langmuir adsorption isotherm.	
CO5	Measure the rate constant, order and activation energy of the reaction using chemical kinetics.	
CO6	Design the experiment for the analysis of samples.	

Unit No.	List of Practicals	Practical (Hrs.)
I	**Viscosity (Anyone)** 1. To determine the molecular weight of a high polymer by using solutions of different concentrations. 2 Determine the radius of the molecule by viscosity measurements.	**4**
II	**Transport number** To determine the transport number of hydrogen and chloride ions by moving boundary method	**4**
III	**Refractometer** To determine the molar refraction of homologues methyl, ethyl and propyl alcohol and show the constancy contribution to the molar refraction by - CH2 group.	**4**
IV	**Chemical Kinetics (Any two)** 1. To determine the energy of activation of the reaction between potassium iodide and potassium persulphate for an unequal concentration of the reactants. 2. To determine the first order velocity constant of the decomposition of hydrogen peroxide by volume determination of oxygen. 3. To study the kinetics of iodination of acetone	**8**
V	**Colorimetry (Any one)** 1. To determine the indicator constant of the methyl red indicator. 2. To estimate copper (II) with EDTA by photometrically.	**4**
VI	**Potentiometry (Any one)** 1. To determine the formal redox potential of Fe2+ / Fe3+ system potentiometrically. 2. To determine the amount of NaCl in the given solution by titration against silver nitrate potentiometrically.	**4**

VII	**pH metry (Any one)** 1. To determine pka value and dissociation constant of given weak acid by pH-metric titration with strong base. 2. To determine pH of various mixtures of sodium acetate and acetic acid in aqueous solution and hence to find the dissociation of acetic acid.	**4**
VIII	**Conductometry (Any one)** 1. To investigate the conductometric titration of mixture of strong and weak acid against strong base. 2. 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. 3. To determine the strength of a given dibasic acid (oxalic / succinic acid) by conductometric titration.	**4**
IX	**Radioactivity (Any one)** 1. To determine plateau voltage of the given G M counter. 2. To determine the resolving time of the GM counter. 3. To determine E_{max} of beta particles.	**4**
X	**Adsorption** To investigate the adsorption of oxalic acid / acetic acid by activated charcoal and test the validity of Freundlich and Langmuir adsorption isotherms.	**4**
XI	**Report on Industrial Visit (Physical Aspect)** 1. To prepare a report on the study of physical properties observed in industry visited. 2. To prepare Report the efforts taken by the visited industry for better yield of industry products.	-

References:

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

T. Y. B. Sc. Chemistry Semester 6		
Title of the Course and Course Code	**Inorganic Chemistry Practical II (CHE3608)**	**Number of Credits: 02**

Course Outcomes (COs) On completion of the course, the students will be able to:	
CO1	Recall and memorize the terms gravimetry, qualitative, quantitative, common ion effect and solubility product.
CO2	Develop the practical skill in gravimetric methods to estimate the amount of metal ion gravimetrically.
CO3	Determine the concentration of metals ions by colorimetrically.
CO4	Adapt and analyze the separation of metal ions by qualitative analysis and identify the groups based on solubility product and common ion effect. Separate and test the metal ions by column/paper chromatography.
CO5	Infer the observation and compile the result.
CO6	Develop practical training skills by industrial visits.

Sr. No.	**Topics Any ten experiments from the given list of experiments (Qualitative or Quantitative)**	**Practical (hrs.)**
I	**Quantitative - Gravimetric (Any Three)** 1. Gravimetric estimations of Fe as Fe_2O_3. 2. Gravimetric estimations of Nickel as Ni - DMG. 3. Gravimetric estimations of Al as Aluminum oxide / oximate. 4. Gravimetric estimations of Ba as $BaSO_4$ using homogeneous precipitation method.	**12**
II	**Quantitative - Colorimetric (Any Two)** 1. Colorimetric estimations of Iron by thiocyanate method. 2. Colorimetric estimations of Cobalt by using the R - nitroso salt method. 3. Colorimetric estimations of Titanium by H_2O_2. 4. Colorimetric estimations of Copper.	**8**
III	**Quantitative - Physico-chemical Experiments** Prepare solution of Fe(III)/Cu(II) and salicylic acid in different molar proportion and determine metal ligand ratio in the complexes.	**4**
IV	**Qualitative Analysis (Any Four)** 1. Qualitative semi-micro analysis of mixtures containing four radicals. Emphasis should be given to the understanding of the chemistry of different reactions and to assign the most probable composition (4 mixtures). 2. Separation and identification of binary mixture of cations by - column chromatography (including colorless Zn + Al / Zn + Mg) or by paper chromatography (separation of Fe^{3+}, Al^{3+}, and Cr^{3+}).	**16**
	Industrial visit One day visit to a chemical industry and report writing.	

References:

1. Analytical Chemistry by G. D. Christian 6th Edition.
2. Vogel's Textbook of Quantitative Chemical Analysis 6th Edition by R. C. D. Denney, J. D. Barnes, M. J. K. Thomas.
3. Macro and Semi - micro *Qualitative Inorganic Analysis* Arthur I*Vogel*, 5th Edition.

T. Y. B. Sc. Chemistry Semester 6		
Title of the Course and Course Code	**Organic Chemistry Practical II (CHE3609)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Define the basic terms in organic qualitative, quantitative analysis. Recall the types of volumetric analysis and purification techniques.	
CO2	Explain the reactions involved in organic qualitative analysis, volumetric estimations, organic preparations. Carry out the separation of binary organic mixture [(solid + liquid), (liquid + liquid)], followed by elemental analysis, functional group detection and physical constant of individual components.	
CO3	Identify and apply the appropriate solvent system for purification (crystallization) and Thin Layer chromatography techniques to distinguish the product in organic synthesis.	
CO4	Examine the tests, observations to infer structural formula of unknown organic compounds and quantification of organic substances by volumetric analysis.	
CO5	Interpret and explain the results of organic qualitative analysis of unknown binary mixture [(solid +liquid), (liquid +liquid)], volumetric analysis. Justify product of organic synthesis by comparing different spectrophotometric data.	
CO6	Predict and compile the results of qualitative, quantitative analysis and organic synthesis. Develop skills required in chemistry such as proper handling of apparatus and chemicals.	

Sr. No.	Topics (Minimum 10 Experiments)	Practical (hrs.)
I	**Organic Qualitative Analysis of Binary Mixture (L+S, L+L) [Minimum 4 mixtures]** 1. Determination of Nature. 2. Separation of the mixture into two components. 3. Type of the mixture. 4. Purification of the component. 5. Individual analysis of the compound a) Preliminary test b) To determine physical constant. c) To determine elements. d) To determine functional group	**16**
II	**Organic Estimations [Any Two]** 1. Estimation of aniline. 2. Estimation of ethyl benzoate. 3. Estimation of molecular weight of an acid. 4. Estimation of saponification value of the given oil.	**8**
III	**Organic Preparations [Any Four]** 1. Preparation of benzpinacol from benzophenone. 2. Preparation of benzoic acid from ethyl benzoate. 3. Preparation of quinone to hydroquinone. 4. Preparation of benzoyl glycine from hippuric acid 5. Isolation of caffeine from tea leaves. 6. Preparation of para bromo acetanilide from acetanilide.	**16**

	7. Preparation of para nitroiodobenzene from para nitroaniline.	
IV	**Report on Industrial Visit (Organic Synthesis)** 1. Report any five reactions taking place in the visited industry. 2. Report the synthesis processes of any five products of the visited industry.	-

References:

1. Practical Organic Chemistry by - A. I. Vogel.
2. Practical Organic Chemistry by - O. P. Agarwal.

T. Y. B. Sc. Chemistry Semester 6		
Title of the Course and Course Code	**Polymer Chemistry (CHE3611)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Define and describe the basic concepts of polymers. Classify the type and discuss the physical properties of polymers.	
CO2	Distinguish between simple compounds, polymers, natural, synthetic, organic and inorganic polymers. Explain Polymerisation Techniques with suitable examples.	
CO3	Classify the polymer reactions and their applications. Discuss the use of polymer according to its physical and chemical properties.	
CO4	Predict the Mechanisms of polymerization and Polymer reactions and explain their effects on physical and chemical properties.	
CO5	Determine the reaction for synthesis of given polymer and decide the reaction to change polymer properties.	
CO6	Determine and modify the structure of the polymer according to its application.	

Unit No.	**Title of Unit and Contents**	**No. of Lectures**
I	a) **Introduction to Polymer Chemistry** Brief History, Polymer definition, Classification (based on Origin, Thermal response and their form), Structures, Chemical bonding & Molecular forces in Polymers. b) **Nomenclature of Polymers** Nomenclature of Polymers - i) Common/Trivial names ii) Source - Based names, iii) Structure-Based names (Non IUPAC), iv) IUPAC Structure-based and Linkage-based nomenclature system and v) Trade names / Brand names & Abbreviations	**7**
II	**Molecular Weights of Polymers** a) Average Molecular weight, Number Average & Weight Average Molecular weight, Molecular weight & degree of polymerisation, Practical significance of polymer molecular weights b) Molecular weight determination by End Group Analysis & Viscosity method and c) Problems based on Number Average & Weight Average Molecular weight.	**5**
III	**Chemistry of Polymerization with Suitable Examples** a) Introduction: Functionality and solubility of monomer b) Chain Polymerization: Free radical Polymerization, Ionic	**7**

	polymerization, Co-ordination polymerization - Ziegler-Natta catalyst c) Step Polymerization: Polycondensation, Polyaddition polymerization, and Ring Opening polymerization.	
IV	**Polymerisation Techniques with suitable examples** Bulk polymerisation, Solution polymerization, Suspension polymerization, Emulsion polymerization, Melt polycondensation, Solution Polycondensation, Interfacial condensation, electrochemical polymerisation, Salient features of different polymerization techniques.	**5**
V	**Polymer Reactions** Introduction, Hydrolysis, Hydrogenation, Addition and Substitution reactions, Cross-linking reactions, Cure reactions, Reactions of various aliphatic and aromatic pendant groups in polymers.	**6**

PRACTICALS (Any Six)

Sr. No.	Contents	Lectures
1	Synthesis of polyesters.	1
2	Preparation of Urea formaldehyde resin.	1
3	Determination of hydroxyl value.	1
4	Preparation of epoxy resin.	1
5	Preparation of varnish, distemper, primer, undercoat and topcoat.	1
6	Characterization of surface coating viscosity, gloss, impact resistance, crosscut adhesion, scratch resistance and hiding power.	1
7	Preparation of nylon 66.	1
8	Preparation of P.F. ion exchange resin.	1
9	Preparation of poly (vinyl acetate) from PVA.	1
10	Determination of saponification value	1

References:

1. Polymer Science by V. R. Gowarikar, N. V. Vishvanathan, Jaydev Shreedhar New Age International Ltd. Publisher 1996 (Reprint 2012)
2. Textbook of Polymer Science by Fred Billmeyer, 3rd Edn. A Wiely-Interscience Publication John Wiely & Sons New York 1984. (Reprint 2008)
3. Introductory Polymer Chemistry by G. S. Misra New Age International (P) Ltd. Publisher 1996.
4. Polymer Chemistry by Charles E. Carraher (Jr.), 6th Edn., (First Indian Print 2005), New York- Basel.
5. Inorganic Polymers by G. R. Chatwal Himalaya Publishing House 1st Edn.1996

6. Polymer Science - A Text Book by V. K. Ahluwalia, Anuradha Mishra.
7. Principle of Polymer Science by P. Bahadur, N. V. Sastry, 2nd Edn., Narosa Publishing House.
8. Polymer Chemistry by Ayodhya Singh, 2008, Published by Campus Book International, New Delhi.
9. Organic Polymer Chemistry by Jagdamba Singh, R. C. Dubey, 4th Edn., 2012.
10. Advanced Polymer Chemistry by V. K. Selvaraj, 1st Edn., 2008, Published by Campus International, New Delhi.
11. Organic Polymer Chemistry by V. Jain, IVY Publishing House, New Delhi.
12. Principles of Polymerisation by George Odian 3rd Edn. John Wiely & Sons, New York.

T. Y. B. Sc. Chemistry Semester 6		
Title of the Course and Course Code	**Analytical Methods (CHE3612)**	**Number of Credits: 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Summarize the techniques and steps involved in analytical chemistry. Recall the concepts of analytical chemistry.	
CO2	Interpret the results and observations obtained in form the various analytical experiments using advanced computational methods.	
CO3	Apply the analytical techniques in the analysis of soil, water, cosmetics and food products.	
CO4	Distinguish between various chromatographic techniques and their application in analysis of ions and paints.	
CO5	Prioritize the uses of phenolphthalein in trap cases; analyze arson accelerants gasoline and Pb, As, Cr from the cosmetic product in connection with IS4707.	
CO6	Create the spectrophotometric analytical methods for estimation of macro nutrients encompassing Potassium, Calcium, Magnesium, Iron, Caffeine and Benzoic Acid in different samples.	

Unit No.	**Title of Unit and Contents**	**No. of Lectures**
I	**Introduction** Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures Finding the best straight line, Calibration curves, Standard addition, internal standards, A spreadsheet for least squares.	**4**
II	**Analysis of soil** Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.	**3**

III	**Analysis of water** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. a. Determination of pH, acidity and alkalinity of a water sample. b. Determination of dissolved oxygen (DO) of a water sample.	**3**
IV	**Analysis of food products** Nutritional value of foods, idea about food processing and food preservations and adulteration. a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. b. Analysis of preservatives and colouring matter.	**3**
V	**Chromatography** Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}). b. To compare paint samples by TLC method.	**3**
VI	**Ion-exchange** Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).	**4**
VII	**Analysis of cosmetics** Major and minor constituents and their function a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.	**4**
VIII	**Suggested Applications (Any one)** a. To study the uses of phenolphthalein in trap cases. b. To analyze arson accelerants. c. To carry out analysis of gasoline. d. To estimate the Pb, As, Cr from the cosmetic product in connection with IS4707.	**4**
IX	**Suggested Instrumental demonstrations** a. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry. b. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets. c. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.	**8**

References:

1. Willard, H. H., Merritt, L. L., Dean, J. & Settoe, F. A. Instrumental Methods of Analysis. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
2. Skoog, D. A. Holler F. J. & Nieman, T. A. Principles of Instrumental Analysis, Cengage Learning India Ed.
3. Skoog, D. A.; West, D. M. & Holler, F. J. Fundamentals of Analytical Chemistry, 6th Ed., Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman.
5. Dean, J. A. Analytical Chemistry Notebook, McGraw Hill.
6. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry 2nd Ed., W. H. Freeman and Co., N. Y. USA (1982).
8. Cooper, T. G. The Tools of Biochemistry, John Wiley and Sons, N. Y. USA. 16 (1977).
9. Vogel, A. I. Vogel's Qualitative Inorganic Analysis, 7th Ed., Prentice Hall.
10. Vogel, A. I. Vogel's Quantitative Chemical Analysis, 6th Ed., Prentice Hall.
11. Robinson, J. W. Undergraduate Instrumental Analysis, 5th Ed., Marcel Dekker, Inc., New York (1995).
12. Practical skills in Chemistry by John R. Dean, Alan M. Jones, Prentice Hall, 2002.