

Deccan Education Society's
FERGUSSON COLLEGE (Autonomous)
PUNE

SYLLABUS UNDER AUTONOMY
Three Years B. Sc. Degree Course in Chemistry

SYLLABUS FOR T. Y. B. Sc. Chemistry
From Academic Year 2018-2019
SEMESTER - V

**Deccan Education Society's
FERGUSSON COLLEGE (AUTONOMOUS), PUNE 411004
Scheme of Course Structure (Faculty of Science)
2018-2019
T. Y. B. Sc. - Chemistry**

Semester	Course Code	Title	Paper No.	Credits	Exam (I + E)	Marks (50/50)
V	CHE3501	Physical Chemistry I	I	3	50 + 50	100
	CHE3502	Inorganic Chemistry I	II	3	50 + 50	100
	CHE3503	Organic Chemistry I	III	3	50 + 50	100
	CHE3504	Analytical Chemistry I	IV	3	50 + 50	100
	CHE3505	Nuclear Chemistry I	VA	3	50 + 50	100
		OR				
	CHE3506	Biochemistry I	VB	3	50 + 50	100
	CHE3507	Industrial Chemistry I	VIA	3	50 + 50	100
		OR				
	CHE3508	Environmental Chemistry I	VIB	3	50 + 50	100
	CHE3511	Physical Practicals I	Practicals - I	2	50 + 50	100
	CHE3512	Inorganic Practicals I	Practicals - II	2	50 + 50	100
CHE3513	Organic Practicals I	Practicals - III	2	50 + 50	100	
VI	CHE3601	Physical Chemistry II	I	3	50 + 50	100
	CHE3602	Inorganic Chemistry II	II	3	50 + 50	100
	CHE3603	Organic Chemistry II	III	3	50 + 50	100
	CHE3604	Analytical Chemistry II	IV	3	50 + 50	100
	CHE3605	Nuclear Chemistry II	VA	3	50 + 50	100
		OR				
	CHE3606	Biochemistry II	VB	3	50 + 50	100
	CHE3607	Industrial Chemistry II	VIA	3	50 + 50	100
		OR				
	CHE3608	Environmental Chemistry II	VIB	3	50 + 50	100
	CHE3611	Physical Practicals II	Practicals - IV	2	50 + 50	100
	CHE3612	Inorganic Practicals II	Practicals - V	2	50 + 50	100
	CHE3613	Organic Practicals II	Practicals - VI	2	50 + 50	100

T.Y. B. Sc. (CHEMISTRY) SEMESTER V
CHEMISTRY PAPER – I
TITLE: Physical Chemistry I
PAPER CODE: CHE3501

[CREDITS -3]

Learning Objectives:

1. To know about chemical kinetics of third order reactions and numericals.
2. To know nuclear stability, radio activity and their application, numericals.
3. To know the concept of Electrolysis and Electrolytic conductance, numericals.
4. Gibb's Phase rule, one component system, two component system and numericals.
5. Concept of Adsorption, BET equation, Surface area determination and numericals.

Unit	Title & Contents	No. of Lectures
Unit - I	<p>Chemical Kinetics Recapitulation of chemical kinetics, Third order reaction of 3 types (i) $3A \rightarrow \text{Products}$ (ii) $A+2B \rightarrow \text{Products}$ (iii) $A+B+C \rightarrow \text{Products}$. 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. Integral equation of $nA \rightarrow \text{Products}$, Effect of temperature on the rate of reaction, energy of activation, collision theory of reaction rates, kinetics of parallel reactions, For reversible reactions: differential rate laws for forward and reverse reactions both are first order, forward first order while reverse reaction of second order, forward second order, reverse first order and Both second order. Integrated rate laws for both reactions of first order, Numericals.</p>	12
Unit - II	<p>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, measurements 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-</p> <ol style="list-style-type: none"> 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 patients body, Goiter 	12
Unit - III	<p>Electrolysis and Electrical Conductance 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.</p>	12
Unit - IV	<p>Phase Rule Meaning of Phase, components' and degree of freedom with examples,</p>	8

	Definitions, Gibb's phase rule, one component system (moderate pressure only) for sulphur and water system, two component system for silver-lead and zinc-cadmium.	
Unit - V	Adsorption Adsorption phenomenon, Adsorption of gases by solids, Types of adsorption, Freundlich, Langmuir and Temkin isotherms, Adsorption of solute by solids, Types of adsorptions (Physical & Chemisorptions). BET equation (no derivation), determination of surface area using Langmuir and BET equations.	4
	References: <ol style="list-style-type: none"> Essentials of Physical Chemistry by B.S. Bahl, G.D.Tuli and Arun Bahl Edition 2014 S. Chand and Company Ltd. Principles of Physical Chemistry, Fourth Edition by S.H. Marron and C. F. Pruton Physical Chemistry a molecular approach by Donald A. McQuarrie, John D. Simon Quantum Chemistry by Donald Mcquarrie Fundamentals of quantum Chemistry by James E. House Elements of physical Chemistry by Atkins and Paula, fifth edition 2009(Indian Edition) Source book of Atomic energy by Glasstone. Chemistry by Chang Fundamentals Molecular spectroscopy by C. N. Banwell. Essentials of Nuclear Chemistry by H.J. Arnikaar 	

T.Y. B. Sc. (CHEMISTRY) SEMESTER V
CHEMISTRY PAPER – II
TITLE: Inorganic Chemistry I
PAPER CODE: CHE3502

[CREDITS -3]

Learning Objectives:

- To understand Molecular Orbital Theory with different types of molecules.
- To know the concept of Crystal Field theory for different complexes
- Definition, nomenclature and classification of organometallic compounds.
- Introduction and Importance of molecular symmetry.
- Introduction, Assumptions and MO treatment to co-ordination complexes.

Unit	Title & Contents	No. of Lectures
Unit - I	Molecular Orbital Theory Limitations of Valence Bond theory(VBT), Need of Molecular orbital theory (MOT), Features of MOT, Formation of molecular orbitals(MO's) by LCAO principle, Rules of LCAO combination, Different types of combination of Atomic orbital(AO's): s-s, s-p, p-p and d-d, Non-bonding combination orbitals(formation of NBMO), M.O. Energy level diagram for homonuclear diatomic molecules, Bond order and existence of molecule from bond order, Energy (β) and magnetic behavior for following molecules or ions: H_2 , H_2^+ , He_2^+ , Li_2 , Be_2 , B_2 , C_2 , N_2 , O_2 , O_2^+ , O_2^- , O_2^{2-} , F_2 , Ne_2 . M.O. energy level diagram, for heteronuclear diatomic molecule like CO, NO, HCl, HF. M.O. energy level diagram, for heteronuclear triatomic molecule like CO_2 , NO_2 .	16
Unit - 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	12

	<p>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.</p> <p>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).</p>	
Unit - III	<p>Organometallic Compounds</p> <p>Definition, nomenclature and classification of organometallic compounds. 18-electron rule and its applications to carbonyls, nitrosyls, cyanides, and nature of bonding involved therein. Simple examples of metal-metal bonded compounds and metal clusters. Metal-olefin complexes: zeises salt (preparation, structure and bonding), Ferrocene (preparation and structure). Hapticity(η) of organometallic ligands, examples of mono tri and penta-hapto cyclopentadienyl complexes.</p>	6
Unit - IV	<p>Molecular Symmetry</p> <p>Introduction and Importance of molecular symmetry, Symmetry of elements and symmetry operations, Concept of a Point Group with illustrations using the following point groups: (i) $C_{\infty v}$ (HCl), (ii) $D_{\infty h}$ (H_2, CO_2), (iii) C_{2v} (H_2O, <i>cis</i> trichloroethylene), (iv) C_{3v} (NH_3), (v) C_{2h} (<i>trans</i> trichloroethylene), (vi) D_{2h} (ethylene), (vii) D_{3h} (BCl_3, $Fe(CO)_5$).</p>	8
Unit - V	<p>Molecular Orbital Theory of Coordination Complexes</p> <p>Introduction, Assumptions and 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 [(i) $[Ti(H_2O)]^{3+}$, (ii) Fluoro complexes of Fe(II) and Fe (III)], effect of pi-bonding on ligand field splitting parameter in $M \rightarrow L$ and $L \rightarrow M$ interactions - Charge transfer spectra, Comparison of VBT, CFT, and MOT.</p>	6
	<p>Reference:</p> <ol style="list-style-type: none"> 1. Concise Inorganic Chemistry by J.D. Lee - 5th Edition. 2. Inorganic Chemistry, - D.F. Shiver & P.W. Atkins- C.H. Longford ELB 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 - Edition. 5. New Guide to Modern Valence Theory by G.I. Brown – 3rd Edition . 6. Co-ordination Compounds by Baselo and Pearson. 7. Chemical application to Symmetry and Group theory – F. A. Cotton 8. Theoretical Inorganic Chemistry by Day and Selbin. 9. Inorganic Chemistry by A. G. Sharpe - 3rd Edition. 10. Coordination Chemistry by A. K. De. 	

T.Y. B. Sc. (CHEMISTRY) SEMESTER V
CHEMISTRY PAPER – III
TITLE: Organic Chemistry I
PAPER CODE: CHE3503

[CREDITS -3]

Learning Objectives:

1. To understand reaction mechanism involved in Ester hydrolysis, Amide Hydrolysis, Sandmeyer reaction, Condensation reaction, Epoxidation reaction etc.
2. To know Nucleophilic addition reactions including mechanisms and selectivities.
3. Methods, conditions of protection and deprotection of various functional groups.
4. Mechanisms and regioselectivity involved in free radical, Photochemistry and Cycloaddition reactions.
5. Principles and significance of green chemistry
6. Concept of Stereochemistry, prochirality and chiral auxiliaries.

Unit	Title & Contents	No. of Lectures
Unit - 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
Unit - 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, Organo magnesium, Organocopper, Organolithium.	8
Unit - III	Protection and Deprotection of functional groups Protection and Deprotection of carbonyl, amine, hydroxyl and carboxylic acid functional groups.	7
Unit - IV	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, photorearrangements 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
Unit - V	Green chemistry Principles and significance of green chemistry, role of Ultrasound, microwaves and ionic liquids in chemical reactions.	6
Unit - VI	Stereochemistry Prochirality, stereochemistry of stereospecific & stereoselective reactions, chiral auxiliaries, asymmetric synthesis.	5
	References: <ol style="list-style-type: none"> 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 6thEdn.
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 V
CHEMISTRY PAPER – IV
TITLE: Analytical Chemistry I
PAPER CODE: CHE3504

[CREDITS -3]

Learning Objectives:

1. To know Gravimetric Analysis with precipitation formation, Co-precipitation, postprecipitation and remedies for their minimization.
2. Principle of thermal analysis, classification of thermal techniques.
3. Introduction of Electromagnetic spectrum, Interaction of electromagnetic radiations with the matter, Mathematical Statement and derivation of Lambert's Law and Beer's Law.
4. Principles of polarographic analysis.
5. Introduction and theory of atomic absorption spectroscopy.
6. Introduction and theory of atomic emission spectroscopy.
7. To know about Quality control, ISO Quality ISO QA Quality policy.

Unit	Title & Contents	No. of Lectures
Unit - I	Gravimetric Analysis 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, postprecipitation 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.	10
Unit - 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 problem.	6
Unit - 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,	8

	Numerical Problems	
Unit - IV	Polarography 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	8
Unit - 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	6
Unit - 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.	6
Unit -VII	Quality Control and Quality Assurance in Analytical Chemistry Quality control , ISO Quality ISO QA Quality policy, quality assurance, quality system, quality management , quality system, recovery and reprocess, Rejected material, rejected goods, Shelf life/Expiration dating period, Packaging material, process suitability, Accreditation, quality standard, Safety, statistical control, waste disposal, National Good laboratory Practice(GLP), National GLP monitoring authority	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 10. https://www.slideshare.net/LavakusaBanavatu/quality-control-assurance-in-analytical-chemistry 11. Quality Assurance and Quality Control in the Analytical Chemical Laboratory: A Practical Approach, First Edition -Konieczka, Piotr.	

T.Y. B. Sc. (CHEMISTRY) SEMESTER V

CHEMISTRY PAPER – VA

TITLE: Nuclear Chemistry I

PAPER CODE: CHE3505

[CREDITS -3]

Learning Objectives:

1. To understand about atomic nucleus, properties of nucleons and nuclei.
2. To study different nuclear models.

3. To study the concept of Radioactivity and decay kinetics.
4. To study different nuclear reactions and Bethe's notation.

Unit	Title & Contents	No. of Lectures
Unit - I	The atomic nucleus, properties of nucleons and nuclei The atom, elementary particles, sub-nucleons, quarks, classification of nuclides, nuclear stability-even odd nature, N/Z ratio, binding energy, nucleus, its size and shape, mechanical effects due to orbiting and spinning of nucleons, Magnetic quantum numbers, principal and radial quantum number.	8
Unit - II	Nuclear Models The Shell model, the periodicity in nuclear properties, salient features of Shell Model, merits of shell model, the liquid drop model, semi-empirical binding energy equation, imitations of liquid drop model	12
Unit - III	Radioactivity Types of radioactive decay, general characteristics of decays, decay kinetics, Alpha decay: Alpha active nuclides, the alpha energy spectrum, Geiger-Nuttals law, The theory of alpha decay, Beta decay: Types of beta decay, absorption and range through matter Fermi theory of beta decay (mathematical details are not expected), Gamma decay: Nuclear isomerism and isomeric transitions, internal conversion, Auger effect, Artificial radioactivity	16
Unit - IV	Nuclear Reactions Bethes notation, types of nuclear reactions, conservation of nuclear reaction, reaction cross-section, the compound nucleus theory, photonuclear reactions, thermonuclear reactions.	12
	References: 1. Essentials of Nuclear Chemistry: Prof. H. J. Arnikar, 4 th Edition, Wiley Eastern 2. Source book of Atomic energy :Samuel Glasstone, 3 rd Edition, East - West press	

T.Y. B. Sc. (CHEMISTRY) SEMESTER V
CHEMISTRY PAPER – VB
TITLE: Biochemistry I
PAPER CODE: CHE3506

[CREDITS -3]

Learning Objectives:

1. To learn introduction of Cell Biochemistry.
2. To know the types of carbohydrates and their biochemical significance in living organisms.
3. To know the types of lipids, their structure and examples.
4. Structure and classification of Amino Acids and Proteins.
5. To understand the meaning and classification of Enzymes, Vitamins, Coenzymes, Hormones and Immunology.

Unit	Title & Contents	No. of Lectures
Unit - I	Cell Biochemistry Introduction to Cell, Unicellular and Multicellular organisms, Prokaryotes-Structural features of bacteria, morphological study of bacteria: Gram staining. Overview of Eukaryotic cell organelles: Cell membrane, Mitochondria, Endoplasmic reticulum, Golgi complex, Lysosomes, Peroxisomes, Plant cell wall and Chloroplast.	5
Unit - II	Carbohydrates Definition, Biological significance, Classification with examples :	6

	Monosaccharides (aldoses and ketoses), Fischer and Haworth projection formula of Glucose, Fructose, Anomers, Epimers, reducing and non reducing sugars, mutarotation, inversion, reactions of glucose with conc.H ₂ SO ₄ , phenyl hydrazine, oxidizing agents, reducing agents and its significance, glycosidic bonds. Structure and significance: Disaccharides (Maltose, Lactose, Sucrose), Homo and Heteropolysaccharides (Starch, Glycogen, Cellulose, Chitin and Hyaluronic acid).	
Unit - III	Lipids Introduction, Biological significance, Classification-Simple, compound, steroids and derived lipids. Structure of saturated and unsaturated fatty acids, structure of phospholipids (Phosphatidic acid, Lecithin, Cephalin, Lipositol), structure of sphingomyelin and cholesterol. Amphipathic lipids and their behavior in water. saponification number, acid number, iodine number and their significance. Rancidity of lipids. Types of Lipoproteins and their significance..	6
Unit - IV	Amino acids and Proteins Amino acids: Structure of amino acids, classification of amino acids with examples based on R group, nutritional requirement (essential and nonessential), standard and non standard, polar and nonpolar amino acids, Amphoteric nature of amino acids, Isoelectric pH, zwitter ions, titration curve of glycine. Reactions of amino acid with Ninhydrin, Sanger's, Dansyl chloride , Dabsyl chloride and Edmann's reagents. Peptide bond and its features. Proteins: Introduction, biological functions, classification-based on structure, function and composition. Structural organization of proteins- primary, secondary, tertiary and quaternary structures (general overview). Factors that stabilize protein structure. Denaturation of proteins. Separation and purification techniques.	15
Unit - V	Enzymes Classification-Six major classes of enzymes, Conjugated enzymes-Apoenzyme, Holoenzyme, prosthetic group (coenzymes and cofactors). Features of active site. Enzyme specificity, Factors affecting enzyme activity-substrate concentration, pH, temperature, and enzyme concentration, product concentration. Significance of MM equation, LB equation and Km. Enzyme inhibition-competitive, non competitive and uncompetitive with suitable examples.	5
Unit - VI	Vitamins and Coenzymes Classification- Fat soluble and water soluble vitamins (source, biological functions and deficiency disorders), coenzyme forms of vitamin B complex. (Structure not required).	4
Unit -VII	Hormones Definition, classification with examples of hormones, based on biochemical nature, location and mechanism of action, Concept of second messengers-cAMP).	4
Unit-VIII	Basic Concepts of Immunology Types of immunity, Immunological cells, Antigen-Antibody reaction (Agglutination and Precipitation	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 , 14 th edition. 4. Biophysical techniques by Upadhyay and Nath, 3 rd revised edition. 5. Textbook of Microbiology- R. Ananthnarayan and C.K.J. Paniker	

6. Biochemistry by Lubert Stryer
7. Biochemistry by Conn & Stumph

T.Y. B. Sc. (CHEMISTRY) SEMESTER V
CHEMISTRY PAPER – VIA
TITLE: Industrial Chemistry I
PAPER CODE: CHE3507

[CREDITS -3]

Learning Objectives:

1. Introduction and basic requirements of chemical industries.
2. Manufacture of Ammonia, Sulfuric Acid and Nitric Acid.
3. Manufacture of cement with Principle and working.
4. Manufacture of Cane sugar with principle and working.
5. Introduction, importance and basic requirement of fermentation process.
6. Introduction, importance of Pharmaceutical Industry and synthesis of drugs.

Unit	Title & Contents	No. of Lectures
Unit - I	Modern Approach to Chemical Industry Introduction, basic requirements of chemical industries, chemical production, rawmaterials,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, Introduction to copy right act, patent act, trademarks, MSDS(16 points), MSDS of hazardous chemicals(benzene, bromine, 2,4-DNP, chloroform, phenol).	8
Unit - 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 ₂ SO ₄ by contact process, Physico-chemical principles involved uses of H ₂ SO ₄ . c Nitric acid: Manufacture of HNO ₃ by Ostwald`s process, Physico-chemical principles involved, uses of HNO ₃ .	8
Unit - III	Cement Industry Introduction, Importance, composition of Portland cement, raw materials, proportioning of raw materials, manufacture of Portland cement by using modern vertical shaft kiln, rotary kiln verses modern vertical shaft kiln, setting and Hardening of cement, reinforced concrete.	8
Unit - 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, Refining of cane sugar, Utilization of by-products of sugar industries, testing and estimation cane sugar.	9
Unit - 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) from hydrocarbons d) manufacture of alcohol from fruits (wine). Grades of alcohols: Silence spirit, rectified spirit, absolute alcohol, proof spirit, denatured spirit, duty and duty free alcohol. Importance of power alcohol as fuel.	7
Unit - VI	Pharmaceutical Industry Introduction, importance, qualities of good drug, functional and chemotherapeutic drugs. Meaning of the terms: Prescriptions, doses, analgesic,	8

	antipyretic, diuretic, anesthetics, antibiotics, anti-inflammatory, anti-viral, tranquilizer, anti-ulcer, antialergic and bronchodilators, cardiovascular, cold preparations, anti-hypertensive, cough preparation, anti-neoplastics, sedative and hypnotics, steroidal, contraceptive, histamine and antihistamine. Synthesis and uses: paracetamol, sulphanilamide, benzocaine, aspirin.	
	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 hand book of Industrial Chemistry, 9th Edition- Jems A. Kent 4. Industrial chemistry – R.K. Das, 2 nd Edition, 1976. 5. Hazards in the Chemical Laboratory, 2 nd Edition- G. D. Muir, The Chemical Society, London	

T.Y. B. Sc. (CHEMISTRY) SEMESTER V
CHEMISTRY PAPER – VIB
TITLE: Environmental Chemistry I
PAPER CODE: CHE3508

[CREDITS -3]

Learning Objectives:

1. To know about concepts and scope of Environmental Chemistry,
2. To study Atmosphere, Air pollution, Hydrosphere and Water pollution.
3. To study Environmental Health and Toxicology.

Unit	Title & Contents	No. of Lectures
Unit - I	Concepts and scope of Environmental Chemistry Introduction, Terminologies, Units of concentration and Segments of Environment	2
Unit - II	Atmosphere Composition and structure of atmosphere, Evolution of Atmosphere, Earth radiation balance, Chemical and photochemical reactions in atmosphere, Chemistry of O ₃ , SO _x , NO _x and chlorides in atmosphere	8
Unit - III	Air Pollution Primary air pollutants, Sources, sinks, and control of CO, SO _x , NO _x and HC, Sampling of air, 3.4 Particulate matter: inorganic and organic, Smog: reducing and photochemical, Radioactivity in atmosphere, Effect of atmosphere pollution on biosphere and corrosion, Chemistry of some air pollution incidents, London smog (1952, 1957), TCDD- Italy (1976), Bhopal (1984)	12
Unit - IV	Hydrosphere Water resources, Physical chemistry of sea water: composition, equilibria, pH, pE, Aquatic environment and stratification of water bodies, Complexation in natural and waste water, Humic substances, Microbially mediated aquatic reactions, nitrogen cycle, iron and manganese bacteria	4
Unit - V	Water Pollution Classification of water pollutants, Organic pollutants, Pesticides : Classification, persistence, biodegradation, Detergents, Eutrophication, Marine pollution, Oil pollution, Inorganic pollutants : Acid mine drainage, remedial measures, sediments and radioactive material, Thermal pollution, Water quality parameters for drinking, surface and irrigation, Sampling and monitoring water quality parameters: pH, D.O. (Winkler Method), COD, TOC, Total hardness, free chlorine, Chemical specification of Hg, Pb, As. Chemistry of some water pollution cases: Minamata, arsenic, calamity in West Bengal/Indian rivers	16

Unit - VI	Environmental Health and Toxicology Types of environmental health hazards, Soil toxicology, Toxic chemicals, organic and inorganic chemicals in the soil, Pesticides and human health, Geological hazards of Earthquakes, Volcanoes, Floods, Landslides, Erosion	6
	Reference Books: <ol style="list-style-type: none"> 1. Environmental Chemistry – A. K. De, 5th Edition (New age international publishers) 2. Environmental Chemistry – J. W. Moore and E. A. Moore (Academic Press, New York) 3. Environmental Chemistry – A. K. Bhagi and C. R. Chatwal (Himalaya Publishing House) 4. Analytical Chemistry – G. D. Christian 4th Edition (John Wiley and Sons) 5. Toxicology principles and methods – M. A. Subramaniam, MJP Publisher, Chennai 6. Principles of environmental science, inquiry and applications – William P. Cunningham and Mary Ann Cunningham, Tata McGraw-Hill Publishing company limited 	

T.Y. B. Sc. (CHEMISTRY) SEMESTER V
PAPER –Practicals I
TITLE: Physical Practicals I
PAPER CODE: CHE3511

[CREDITS -2]

	Title & Contents	No. of Practicals
Any Ten Experiments from the given List of Experiments		10
Practical – I	Adsorption To investigate the adsorption of oxalic acid /acetic acid by activated charcoal and test the validity of Freundlich and Langmuir adsorption isotherms.	
Practical – II	Phenol-water system To study the effect of addition of salt on critical solution temperature of phenol-water System.	
Practical – III	Colorimetry (any One) <ol style="list-style-type: none"> 1. Determination of λ_{\max} and concentration of unknown solution of KMnO_4 in 2N H_2SO_4 2. To determine the indicator constant of methyl red indicator 	
Practical – IV	Potentiometry (any Two) <ol style="list-style-type: none"> 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 solution. 2. Determine the standard oxidation potential of the metal metal-ion electrode by using secondary standard calomel electrode. 3. To determine the concentrations of strong acid and weak acid present in the mixture by titrating with strong base. 	
Practical – V	pH metry (any One) <ol style="list-style-type: none"> 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 	

Practical – VI	Conductrometry (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 given solution of lead nitrate by conductometric titration with sodium sulphate.	
Practical - VII	Refractometry (any One) 1. To determine the molecular refractivity of the given liquids A, B, C and D. 2. To determine the specific refractivity's of the given liquids A and B and their mixture and hence determine the percentage composition of the mixture C.	
Practical - VIII	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.	

T.Y. B. Sc. (CHEMISTRY) SEMESTER V

PAPER – Practicals II

TITLE: Inorganic Practicals I

PAPER CODE: CHE3512

[CREDITS -2]

	Title & Contents	No. of Practicals
	Any Ten Experiments from the given List of Experiments	10
Practical – I	Gravimetric estimations (Any 3) 1. Fe as Fe_2O_3 2. Nickel as Ni – DMG 3. Al as Aluminium oxide 4. Ba as $BaSO_4$ using homogeneous precipitation method.	
Practical – II	Qualitative Analysis (Any 7 mixtures including Borates and Phosphates) 1. Simple mixtures (without phosphate or borate) 2. Mixtures containing PO_4^{3-} (With PO_4^{3-} removal) 3. Mixtures containing BO_3^{3-} (With BO_3^{3-} removal)	

T.Y. B. Sc. (CHEMISTRY) SEMESTER V
PAPER – Practicals III
TITLE: Organic Practicals I
PAPER CODE: CHE3513

[CREDITS -2]

	Title & Contents	No. of Practicals
	Any Ten Experiments from the given List of Experiments	10
Practical – I	Organic Qualitative analysis of Binary mixture (S+S, L+S, L+L) [Minimum 4 mixtures] <ol style="list-style-type: none"> 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 <ol style="list-style-type: none"> a. Preliminary Test b. To determine physical constant. c. To determine elements. d. To determine functional group 	
Practical – II	Organic Estimations [Any 2] - Estimation of acetone, acetamide, glucose and acid value of the given oil.	
Practical - III	Organic Preparations [Any 4] <ol style="list-style-type: none"> 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. 	

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SEMESTER - VI

T.Y. B. Sc. (CHEMISTRY) SEMESTER VI
CHEMISTRY PAPER – I
TITLE: Physical Chemistry II
PAPER CODE: CHE3601

[CREDITS - 3]

Learning Objectives:

1. To study investigation of Molecular structure using spectroscopic techniques.
2. To know principle and concept of Photochemistry.
3. To study Electrochemical cells.
4. Introduction to Quantum Chemistry.

Unit	Title & Contents	No. of Lectures
Unit - 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.	16
Unit - II	Photochemistry Photochemical Reactions, difference between Photochemical and Thermo chemical reactions, Thermopile, Photoelectric Cell, Chemical Actinometer, Laws of Photochemistry, Grothus-Draper law, Stark-Einstein law of Photochemical equivalence, Quantum yield or Efficiency, Calculation of Quantum yield, Photosensitized reactions, Photophysical process, Fluorescence, Phospherences, Chemiluminescence and Photoluminences.	10
Unit - III	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, Capacitors, Types of batteries, applications of EMF measurement, such as a. Solubility product of sparingly soluble salt b. Determination of pH c. Potentiometric titration	12
Unit - IV	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 (wavefunction 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 wavefunction 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 .	10
	References: 1. Essentials of Physical Chemistry by B.S. Bahl, G.D.Tuli and Arun Bahl Edition 2014 S. Chand and Company Ltd. 2. Principles of Physical Chemistry, Fourth Edition by S.H. Marron and C.	

	<p>F. Pruton</p> <p>3. Physical Chemistry a molecular approach by Donald A. McQuarrie , John D. Simon</p> <p>4. Quantum Chemistry by Donald Mcquarrie</p> <p>5. Fundamentals of quantum Chemistry by James E. House</p> <p>6. Elements of physical Chemistry by Atkins and Paula, fifth edition 2009(Indian Edition)</p> <p>7. Source book of Atomic energy by Glasstone.</p> <p>8. Chemistry by Chang</p> <p>9. Fundamentals Molecular spectroscopy by C. N. Banwell.</p> <p>10. Essentials of Nuclear Chemistry by H.J. Arnikaar</p>	
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T.Y. B. Sc. (CHEMISTRY) SEMESTER VI

CHEMISTRY PAPER – II

TITLE: Inorganic Chemistry II

PAPER CODE: CHE3602

[CREDITS -3]

Learning Objectives:

1. To study Chemistry of f- Block Elements
2. To know the Electronic States, Terms and Spectra of transition metal ions.
3. To study the solid state chemistry of ionic solids.
4. To learn the concept of Homogeneous catalysis and an introduction to Bioinorganic chemistry.

Unit	Title & Contents	No. of Lectures
Unit - I	<p>Chemistry of f- Block Elements</p> <p>Introduction of f-block elements- on the basis of electronic configurations, occurrence and reactivity. The shapes of <i>f</i>-orbitals.</p> <p>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.</p> <p>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.</p>	8
Unit - II	<p>Electronic States and Terms for Polyelectronic Atoms</p> <p>Introduction: electronic configuration and electronic states, 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).</p> <p>Terms and micro-states for transition metal atoms/ions.</p>	6
Unit - III	<p>Electronic Spectra</p> <p>Types of electronic transitions like intra –ligand transitions, charge transfer transitions and intra-metal transitions and (<i>d-d</i> 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.</p>	8

Unit - IV	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 cesium 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 ratioLattice energy, Born-Lande equation, Born Haber cycle and its applications, Point defects with respect to Frenkel and Schottky defects	10
Unit - V	Homogeneous Catalysis 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	8
Unit - VI	Bioinorganic Chemistry 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). Metalloproteins-Iron proteins-Introduction of Fe-S proteins, Electron transfer proteins (FeS, Fe ₂ S ₂ , Fe ₃ S ₄ , Fe ₄ S ₄). Transport protein (transferrin) and Storage protein (ferritin), Bioinorganic Chemistry of Fe: Hemoglobin and myoglobin, its structure and functions, Bioinorganic Chemistry of Co: Vitamin-B ₁₂ , its structure and function.	8
	References: 1. Concise Inorganic Chemistry by J.D. Lee - 5 th Edition. 2. Inorganic Chemistry, - D.F. Shiver & P.W. Atkins- C.H. Longford ELBS - 2 nd Edition. 3. Basic Inorganic Chemistry, - F.A. Cotton and G. Wilkinson, Wiely Eastern 4. Concept and Model of Inorganic Chemistry by Douglas – Mc Daniels - 3 rd Edition 5. Co-ordination Compounds by Baselo and Pearson 6. Inorganic Chemistry by J.E. Huheey, 4 th Edition, Pearson Education. 7. Theoretical Inorganic Chemistry by Day and Selbin 8. Inorganic Chemistry by A. G. Sharpe - 3 rd Edition 9. Principles of Bioinorganic Chemistry by S. J. Lippard and J. M. Berg, 1 st Edition	

T.Y. B. Sc. (CHEMISTRY) SEMESTER VI**CHEMISTRY PAPER – III****TITLE: Organic Chemistry II****PAPER CODE: CHE3603****[CREDITS -3]****Learning Objectives:**

1. To study in detail the concepts of Retro synthesis and Natural Products.
2. To study the technique of UV, IR and ¹H NMR – Spectroscopy for Organic compounds.
3. To learn electronic spectra of different molecules and to study ionic solids.
4. To study concepts of ¹³C and Mass Spectroscopy.

Unit	Title & Contents	No. of Lectures
Unit - 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
Unit - II	Natural Products a) Terpenoids: Isolation, Classification. Citral- structure 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.	6
Unit - 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
Unit - IV	IR Spectroscopy Principle of IR Spectroscopy, Fundamental modes of vibrations (3N-6, 3N-5) Types of vibrations (Stretching and bending), Hooke's law, Condition for absorption of IR radiations, vibration of diatomic molecules. Regions of IR Spectrum: fundamental group region, finger print region, aromatic region, Characteristic of IR absorption of functional groups: Alkanes, alkenes, alkynes, alcohol, ethers, alkyl-halides, carbonyl compounds (-CHO, C=O, -COOR-COOH), amines, amides and Aromatic Compounds and their substitution Patterns. Factors affecting on IR absorption: Inductive effect, resonance effect, hydrogen bonding. Application of IR Spectroscopy in determination of structure, chemical reaction and hydrogen bonding.	7
Unit - V	¹H 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.	15

Unit - VI	Introduction to ¹³C and Mass Spectroscopy a) Introduction to ¹³ C NMR Spectroscopy, Types of ¹³ C NMR Spectra: un-decoupled, Proton decoupled, Off-resonance, chemical shift, calculations of chemical shifts of aliphatic, olefinic, aromatic and carbonyl carbons, factors affecting chemical shifts. b) Introduction to mass spectrometry, ionization, rules of fragmentation of alcohols, halides, aldehydes, ketones esters, factors controlling fragmentation.	9
	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 VthEdn. 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 Mc Graw Hill 4. Absorption spectroscopy of organic molecules – V. M. Parikh 8. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer-Verlag (1986).	

T.Y. B. Sc. (CHEMISTRY) SEMESTER VI

CHEMISTRY PAPER – IV

TITLE: Analytical Chemistry II

PAPER CODE: CHE3604

[CREDITS -3]

Learning Objectives:

1. To study the techniques such as Solvent extraction, Chromatography, Gas chromatography, HPLC.
2. Introduction, principle and instrumentation of Electrophoresis, Nephelometry and Turbidimetry.
3. To study Instrumental titration techniques.
4. Introduction to Mass spectroscopy.

Unit	Title & Contents	No. of Lectures
Unit - I	Solvent Extraction 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.	6
Unit - 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	8
Unit - 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 chromatogram and qualitative-quantitative analysis, Applications of gas chromatography	7

Unit - 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	7
Unit - 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
Unit - 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
Unit - VII	Instrumental titration techniques a. Conductometric Titrations: Basic principles, experimental set up titration curves in the titration of (i) strong acid vs, strong base, (ii) weak acid vs, strong base, (iii) weak acid vs, weak base, (iv) Mixture of strong and weak acid/strong weak base vs, strong base/weak base or strong acid/weak acid, (v) sodium chloride vs, silver nitrate (vi) barium hydroxide vs, magnesium sulphate advantages and limitations. b. Potentiometric Titrations: Basic principles, concept of indicator electrode, indicator electrodes for different types of titration, determination of end point from the graphs, advantage and limitations. c. Photometric titrations: Basic principles, titration curves, advantages and limitations	8
Unit - VIII	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 & Merritt-6th Edition 10. Instrumental Titration Techniques: Principles and Applications of the Volumetric Analysis with Emphasis on Aspects of the Measuring and Instrumental Procedures by Friedrich Oehme and Wolfgang Richter.	

T.Y. B. Sc. (CHEMISTRY) SEMESTER VI
CHEMISTRY PAPER – VA
TITLE: Nuclear Chemistry II
PAPER CODE: CHE3605

[CREDITS -3]

Learning Objectives:

1. To study discovery and process of Nuclear Fission.
2. To study different types of Nuclear Reactors and Nuclear Accelerators.
3. To study Detection and Measurement of Nuclear Radiations.
4. Applications of Radioactivity and Radiation Safety precautions.

Unit	Title & Contents	No. of Lectures
Unit - I	Nuclear Fission Discovery of Nuclear fission, The process of Nuclear fission, fission fragments, their mass distribution, fission energy ,fission cross-section and thresholds, fission neutrons, Theory of Nuclear fission.	10
Unit - II	Nuclear Reactors Fission energy, the natural Uranium reactor, the four factor formula, classification of reactors, Breeder reactors, Breeder reactors,	8
Unit - III	Nuclear Accelerators Electrostatic Accelerators, The cockcroft-walton Accelerator, The Vande-Graft Accelerator, Cyclic Accelerator, Linear Accelerator	8
Unit - IV	Detection and Measurement of Nuclear Radiations Scintillation Counters, Scintillation Spectrometry, Scintillation Selection, Photochemical Processes in a Scintillator, Commonly used Scintillator Semiconductor detectors, charge carriers in semiconductors, semiconductors as a detector, neutron detectors, Proton recoil detector, The BF ₃ Counter, The Helium counter	8
Unit - V	Applications of Radioactivity Probing by isotopes, Typical reactions involved in the preparation of radio-isotopes, Szilard - Chalmer reaction, Cow and milk system, Use of charged plates in the collection of Radio - isotopes, radiochemical principles in the use of tracers, Analytical applications – Isotope Dilution Analysis, Neutron Activation Analysis, Radiometric Titrations	10
Unit - VI	Radiation Safety precautions Safety standards, safe working methods, biological effects of radiations	4
	References: <ol style="list-style-type: none"> 1. Essentials of Nuclear Chemistry:Prof.H.J.Arnikaar,4TH Edition,Wiley Estern 2. Source book of Atomic energy :Samuel Glasstone ,3rdedition,East - West press 3. Nuclear Physics by Irving Kaplan 2ndedition 4. Introduction to Nuclear physics and chemistry B.G.Harvey 	

T.Y. B. Sc. (CHEMISTRY) SEMESTER VI
CHEMISTRY PAPER – VB
TITLE: Biochemistry II
PAPER CODE: CHE3606

[CREDITS -3]

Learning Objectives:

1. To study introduction to Metabolism, Carbohydrate Metabolism, TCA Cycle, Amino Acid Metabolism and Lipid Metabolism.
2. To learn the concept of Electron Transport chain and Oxidative Phosphorylation.
3. To study Nucleic Acids, DNA replication and Transcription.
4. To study Translation and Gene Regulation and Introduction to Genetic Engineering.

Unit	Title & Contents	No. of Lectures
Unit - I	Introduction to Metabolism Definition of catabolism and anabolism, Types of metabolic reactions, High energy compounds, Significance of ATP.	2
Unit - II	Carbohydrate Metabolism and TCA Cycle Aerobic and anaerobic glycolysis- structures of intermediates, various enzymes involved and energetics. Fate of Pyruvate, Pyruvate dehydrogenase complex. TCA cycle-enzymatic reactions and energetics	6
Unit - III	Lipid Metabolism Transportation of fatty acids with the help of carnitine, β -oxidation of palmitic acid in mitochondria and its energetic, Triacylglycerol synthesis, ketogenesis.	6
Unit -IV	Amino Acid Metabolism Significance of transamination, deamination, decarboxylation reactions of amino acids, Urea cycle	4
Unit - V	Electron Transport Chain and Oxidative Phosphorylation Location of Electron carriers, Electron transport chain, Proton gradient, Oxidative phosphorylation -Chemiosmotic hypothesis, Inhibitors and Uncouplers of Electron transport chain and Oxidative phosphorylation .	6
Unit - 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 (Macleod and Mcarty, Hershey and Chase experiments), RNA and its types, Central dogma of molecular biology.	7
Unit -VII	DNA Replication Semiconservative model of replication (Messelson and Stahl experiment), Brief account of initiation ,elongation and termination of DNA replication in bacteria. Distinguishing features of DNA polymerase I, II and III.	6
Unit -VIII	Transcription Brief account of initiation- Promoter sequences, elongation and termination of transcription in bacteria. RNA polymerase.	4
Unit - IX	Translation and Gene Regulation Genetic code and its features. Brief account of initiation, elongation and termination of translation in bacteria, Lac operon.	5
Unit - X	Introduction to Genetic Engineering Basic concepts of genetic engineering: Restriction Enzymes, Vectors. Steps involved in gene cloning. Applications of genetic engineering in agriculture, medicine and industry.	2
	References: 1. Lehninger, Principles of Biochemistry, by Nelson and Cox Macmillan Publisher 4 th Edition.	

2. Harper's Illustrated Biochemistry, 26th Edition.
3. Biochemistry by U. Satyanarayana
4. Biotechnology, B. D. Singh, 3rd edition.

T.Y. B. Sc. (CHEMISTRY) SEMESTER VI
CHEMISTRY PAPER – VIA
TITLE: Industrial Chemistry II
PAPER CODE: CHE3607

[CREDITS -3]

Learning Objectives:

1. To study Manufacture of Glass and Fertilizers in terms of Principle, Flow chart and working.
2. To study Manufacture of Soaps, Detergents and Dyes in terms of Principle, Flow chart and working.
3. Introduction and aspects of Small Scale Industries.
4. Introduction and to study processes of Petrochemicals and Eco-Friendly Fuels.

Unit	Title & Contents	No. of Lectures
Unit - I	Glass Industry Introduction, importance, physical and chemical properties of glass, chemical reaction, 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, borosilicate, optical, photosensitive, conducting, glass laminates.	8
Unit - II	Fertilizer Industry Introduction, importance of fertilizers, N,P,K ratio, micronutrients, organic manure, Vermi-compost. Types of fertilizers, a. Nitrogenous fertilizers: Manufacture of urea. b. Phosphatic fertilizers: Manufacture of triple super phosphate. d. Pottash fertilizers. c. Mixed fertilizers: Manufacture of mixed fertilizer.	10
Unit - III	Dyes Introduction, importance, qualities of good dye, color, color and chemical constitution, Otto-Witt's theory of color, Resonance theory, Molecular approach to colour. Classification of dyes according their applications. Meaning of terms: chromophore, auxochrome, bathochromic (red) and hypsochromic (blue) shifts. Synthesis and uses of following dyes: Methyl orange, Rosaniline, crystal violet, phenolphthalein, Florescence, Alizarin, Indigo.	6
Unit - IV	Soaps and Detergents a Soap industry: Introduction, importance, raw materials for soaps, manufacture soap, special soap products, toilet soap, super fatted soap, transparent soap, medicated soap, shaving soap and shaving cream, cleansing powders, shampoos. b Detergent industry: Meaning of the terms detergent and surfactants, emulsion and emulsifying agents, wetting and non-wetting, hydrophobic and hydrophilic nature, amphipathic structures, types of surfactants, raw materials for detergents, manufacture of detergents, washing action of soaps and detergents, detergent builders, additives.	8
Unit - V	Small Scale Industries 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.	6

Unit - VI	Petrochemicals and Eco-Friendly Fuels a) Introduction, occurrence, composition of petroleum, resources, processing of petroleum, petroleum refineries, cracking, calorific value of fuel, octane rating (octane number), cetane number, flash point, applications of petrochemicals, synthetic petroleum, lubricating oils & additives. b) Fuels and eco-friendly fuels: liquid, diesel, bio diesel, gasoline, gaseous fuel (LPG, CNG), aviation fuels. Use of solar energy for power generation.	10
	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 hand book of Industrial Chemistry, 9th Edition, Jems A. Kent 4. Industrial chemistry – R.K. Das, 2nd Edition,1976. 5. The Petroleum chemicals industry by R. F. Goldstine, e &Fn London 6. Fundamentals of petroleum chemical technology by P Below. 7. Petro Chemicals Volume 1 and 2; A Chauvel and Lefevrev ; Gulf Publishing company.	

T.Y. B. Sc. (CHEMISTRY) SEMESTER VI
CHEMISTRY PAPER – VIB
TITLE: Environmental Chemistry II
PAPER CODE: CHE3608

[CREDITS -3]

Learning Objectives:

1. To study Water Treatment, Effluent Management, Lithosphere and Solid Waste Management.
2. To learn Instrumental Methods in Environmental Analysis.
3. To study Natural Resources, Energy, Environment, Green House Effect and Global Warming.
4. To study Ozone Layer: The Earth Protective Umbrella.

Unit	Title & Contents	No. of Lectures
Unit - I	Water Treatment and Effluent Management Domestic sewage, waste water treatment: primary, secondary and tertiary treatments, aerobic, anaerobic and up flow anaerobic sludge bed treatment processes, Industrial waste water treatment i) filtration method ii) ion-exchange method iii) membrane, techniques: ultrafiltration, reverse osmosis and electro dialysis, Treatment of drinking water	8
Unit - II	Lithosphere and Solid Waste Management Composition of lithosphere and types of soil, Organic and inorganic components of soil, Acid base and ion exchange reactions in soil and pH of soil, Chemistry of disposal of solid waste i) sanitary landfills ii) incinerators iii) pyrolysis	4
Unit - III	Instrumental Methods in Environmental Analysis Atomic absorption spectroscopy: basic principle and working, HC lamp as source, flames and furnaces as cells, working curve, application to determination of Hg, As, Be, Zn, Ag, Pb, Mn, Fe, Cu, Cr, Cd, Gas chromatography: basic principle and working, requirements of carrier gas and simple, packed columns, capillary columns, retention time, detectors based on thermal conductivity, electron capture and flame ionization, GC—MS application to detection and determination of CO, HC and pesticides, HPLC: use for non-volatile solutes, principle, working with respect to column, packing material, solvent and	20

	detectors, application to determination of pesticides, PAH as metabolites, Spectrophotometry: determination of NO _x , SO ₂ (Dasgupta method), NH ₃ , CN, PO ₄ , Cd, Pb, hg by their chemical transformation into appropriate coloured compound and measurement at corresponding max value, Chemiluminescence: determination of NO _x and O ₃ , Non dispersive IR spectrometry of determination of CO, Ion selective electrodes: basic principle and working, solid state membrane electrode, glass and fluoride, liquid ion-exchange electrode for NO ₃ and dissolved oxygen (D. O.)	
Unit - IV	Natural Resources, Energy and Environment Natural resources: wood, coal and mineral resources, Cleaner coal combustion by coal conversion: synthane gasifier, methanol, gasohol, solvent refined coal, magneo hydrodynamic generator, Non conventional energy sources: solar, nuclear fission and fusion, dihydrogendioxygen, fuel cell, green gas technology.	6
Unit - V	Green House Effect and Global Warming Introduction, Green house gases, Radiative forcing, Sources and sinks of CO ₂ , Causes of fluctuations in global temperature, Global warming and climate changes, Implications of climate changes	4
Unit - VI	Ozone Layer: The Earth Protective Umbrella Creation of ozone layer, Mechanism of ozone depletion, Probing the ozone shield and ozone hole, Effects of ozone depletion, Chlorofluorocarbons (CFCs), Stability and reactions of CFCs, Harmful effects of CFCs, CFCs substitutes, Remedial steps.	6
	References: 1. Environmental Chemistry – A. K. De, 5th Edition (New age international publishers) 2. Environmental Chemistry – J. W. Moore and E. A. Moore (Academic Press, New York) 3. Environmental Chemistry – A. K. Bhagi and C. R. Chatwal (Himalaya Publishing House) 4. Analytical Chemistry – G. D. Christian 4th Edition (John Wiley and Sons) 5. Environmental Chemistry – H. Kaur 2nd Edition 2007, Pragati Prakashan, Meerut, India	

T. Y. B. Sc. (CHEMISTRY) SEMESTER VI
CHEMISTRY PAPER – Practicals IV
TITLE: Physical Practicals II
PAPER CODE: CHE3611

[CREDITS -2]

	Title & Contents	No. of Practicals
	Any Ten Experiments from the given List of Experiments	10
Practical - I	Viscosity (any One) 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.	
Practical – II	Transport number To determine the transport number of hydrogen and chloride ions by moving boundary method.	

Practical – I	Refractometry To determine the molar refraction of homologues methyl, ethyl and propyl alcohol and show the constancy contribution to the molar refraction by - CH ₂ group.
Practical – III	Chemical Kinetics (any Two) <ol style="list-style-type: none"> 1. To determine the energy of activation of the reaction between potassium iodide and potassium persulphate for an unequal concentrations 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.
Practical – IV	Colorimetry (any One) <ol style="list-style-type: none"> 1. Determination of λ_{\max} and concentration of unknown solution of CuSO₄. 2. To estimate copper (II) with EDTA by photometrically.
Practical – V	Potentiometry (any One) <ol style="list-style-type: none"> 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.
Practical – VI	pH metry (any One) <ol style="list-style-type: none"> 1. To determine p_Ka 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.
Practical – VII	Conductrometry (any One) <ol style="list-style-type: none"> 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.
Practical – VIII	Radioactivity (any One) <ol style="list-style-type: none"> 1. To determine plateau voltage of the given G M counter. 2. To determine the resolving time of GM counter. 3. To determine E_{max} of beta particles.
Practical – IX	Interpretation of Spectra. <ol style="list-style-type: none"> 1. Rotational spectra of diatomic molecules CO/ HCl/ DCl 2. Rotational spectra of triatomic molecules CO₂/HCN 3. Rotational –Raman spectra of diatomic molecules.
Practical – X	Report on Industrial Visit (Physical Aspect) <ol style="list-style-type: none"> 1. To prepare a report on the study physical properties observed in industry visited. 2. To prepare Report the efforts taken by the visited industry for better yield of industry products.

T. Y. B. Sc. (CHEMISTRY) SEMESTER VI
CHEMISTRY PAPER – Practicals V
TITLE: Inorganic Practicals II
PAPER CODE: CHE3612

[CREDITS -2]

	Title & Contents	No. of Practicals
	Any Ten Experiments from the given List of Experiments	10
Practical – I	Volumetric Estimations (Any Three) <ol style="list-style-type: none"> 1. Mn by Volhard's method. 2. Estimation of NO_2^- by using KMnO_4. 3. Estimation of Cu by Iodometry from copper complex. 4. Fertilizer analysis (PO_4^{3-}). 5. Determination of magnesium from the supplied commercial sample of milk of magnesia tablet. 6. Estimation of Nickel(II) complexometrically using murexide indicator 	
Practical – II	Inorganic Preparations (Any 3) <ol style="list-style-type: none"> 1. Preparation of Potassium Trioxalatoferate (III), $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$. 2. Preparation of Manganese (III) acetylacetonate $[\text{Mn}(\text{acac})_3]$. 3. Preparation of Tris(Thiourea)Copper (I) Chloride $[\text{Cu}(\text{Thiourea})_3]\text{Cl}$. 4. Potassium diaquobis-(oxalate)cuprate(II) $\text{K}_2[\text{Cu}(\text{C}_2\text{O}_4)_2 \cdot (\text{H}_2\text{O})_2]$. 5. Bis(ethylenediamine)iron(II)sulphate $[\text{C}_2\text{H}_4(\text{NH}_2)_2\text{FeSO}_4 \cdot 4\text{H}_2\text{O}]$. 6. Tris-acetyl acetonatoiron(III) $[\text{Fe}(\text{acac})_3]$ 	
Practical- III	Colorimetric Estimations (Any Two) <ol style="list-style-type: none"> 1. Iron by thiocyanate method. 2. Cobalt by using R-nitroso salt method. 3. Titanium by H_2O_2. 	
Practical - IV	Separation of binary mixture of cations by Column Chromatography (Two mixtures) (One mixture should be colorless, Zn + Al, Zn + Mg)	
Practical - V	Report on Industrial Visit. (Analytical Techniques) Experiment: 1. Report of analytical techniques observed in visited industry (Any three techniques like AAS, XRD, NMR, IR, UV, Mass Spectrum, SEM, TEM, etc) Experiment: 2. Report any two Chromatographic Techniques seen in the visited industry. (TLC, HPLC, GC, Ion Exchange Chromatography etc.)	

T.Y. B. Sc. (CHEMISTRY) SEMESTER VI
PAPER – Practicals VI
TITLE: Organic Practicals II
PAPER CODE: CHE3613

[CREDITS -2]

	Title & Contents	No. of Practicals
	Any Ten Experiments from the given List of Experiments	10
Practical – I	Organic Qualitative Analysis of Binary Mixture(S+S,L+S,L+L) [Minimum 4 mixtures] <ol style="list-style-type: none"> 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 <ol style="list-style-type: none"> a) Preliminary test b) To determine physical constant. c) To determine elements. d) To determine functional group 	
Practical – II	Organic Estimations [Any Two] <ol style="list-style-type: none"> 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. 	
Practical - III	Organic Preparations [Any Four] <ol style="list-style-type: none"> 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 lycopene from tomatoes and determination of λ_{\max} of lycopene using UV spectrophotometer. 6. Isolation of caffeine from tea leaves. 7. Preparation of para bromo acetanilide from acetanilide. 8. Preparation of para nitroiodobenzene from para nitroaniline 	
Practical – IV	Report on Industrial Visit (Organic Synthesis) : <ol style="list-style-type: none"> 1. Report any five reactions taking place in the visited industry. 2. Report the synthesis processes of any five products of the visited industry. 	