TUMKUR UNIVERSITY

Syllabus

for

Bachelor of Science in Chemistry

III and IV Semester

As per Revised-NEP (2024) Curriculum

Effective from the Academic Year 2024-25

Curriculum

Name of the Degree Program : **B.Sc.**

Subject : **Chemistry**

Discipline Core : **Chemistry**

Year of Implementation : **2024-25**

Course Structure for Third and Fourth Semester (Core Papers)

Semester	L	P	T	Total Credits
	4 h / week	4 h / week	-	
III	4 credits	2 credits	-	6
IV	4 credits	2 credits	-	6

Course Structure for Third and Fourth Semester (Discipline Core Elective)

Semester	L	P	T	Total Credits
	3 h / week	-	-	
III	3 credits	-	-	3
IV	3 credits	-	-	3

Examination Structure for Third and Fourth Semester

Semester	Paper title	Semester End Examination		Internal Assessment Marks	Total Marks
		Duration	Marks		
III	Chemistry - III	3h	80	20 (Average of Two Tests 10 M + Average of Two Assignments 10 M)	100
III	Chemistry Practicals - III	3h	40	10 (One Test 5M + One Assignment 5 M)	50
III	Discipline Core Elective Paper – Industrial Chemistry	3h	80	20 (Average of Two Tests 10 M + Average of Two Assignments 10 M)	100

IV	Chemistry - IV	3h	80	20 (Average of Two Tests 10 M + Average of Two Assignments 10 M)	100
IV	Chemistry Practicals - IV	3h	40	10 (One Test 5 M + One Assignment 5 M)	50
IV	Discipline Core Elective Paper – Water Analysis and Treatment Techniques	3h	80	20 (Average of Two Tests 10 M + Average of Two Assignments 10 M)	100

Third Semester

Chemistry-III 60h

Course Objectives

1. To understand the concept of LCAO and the formation of bonding, nonbonding and antibonding MOs.
2. To calculate bond order and understand the relationship between bond order, bond energy and bond length.
3. To interpret the magnetic properties of molecules based on MOT
4. To understand the theories of metallic bonding.
5. To familiarize the principles of electrochemistry and the laws governing it..
6. To understand the properties of carboxylic acids, nitro compounds and heterocyclic compounds.

Course Outcomes

At the end of the course, student will be able to,

1. Draw MO energy level diagrams and to predict magnetic properties.
2. Apply of concepts of weak interactions.
3. Construct electrochemical cells and calculate emf of electrochemical cells.
4. Explain properties of carboxylic acids and nitro compounds and the aromaticity of heterocyclic compounds.

Unit-I 15 h

Chemical Bonding - II

Molecular Orbital Theory (MOT) 8 h

Concept of Linear Combination of Atomic Orbitals: Rules, *s-s, s-p, p-p, p-d* and *d-d* combinations of orbitals, non-bonding combinations of atomic orbitals. Bonding, nonbonding and anti-bonding molecular orbitals. Rules for filling up of electrons in molecular orbitals. Calculation of bond order, relationship between bond order, bond energy and bond length. Magnetic properties based on MOT. Examples of molecular orbital treatment for homonuclear diatomic molecules/ions - H_2, H_2^+, He_2, He_2^+, Li_2, Be_2, B_2, C_2, N_2, N_2^+, O_2, O_2^-, O_2^{2-}, O_2^+ and O_2^{2+}. Molecular Orbital energy level diagrams of hetero-nuclear diatomic molecules like NO, CO and HCl. Comparison of VBT and MOT approaches.

Metallic Bonding 4 h

General properties of metals – Conductivity, luster, malleability and cohesive forces. Theories of bonding in metals: free electron theory, band theory. Prediction of conducting properties of conductors. insulators and semiconductors using band theory. Extrinsic and intrinsic semiconductors. Superconductors – BCS theory.

Weak Interactions 3 h

Hydrogen Bonding – Nature of hydrogen bonding, types, consequences of hydrogen bonding, anomalous properties of HF, H_2O, NH_3, alcohols, carboxylic acids, nitrophenols and biomolecules.

van der Waal's Forces – types, van der Waals forces in noble gases and molecular crystals (iodine, solid CO_2 and solid SO_2).

Unit-II

Chemical Energetics 10 h

Introduction. Exact and inexact differentials. First law of thermodynamics – statements. Need for the second law of thermodynamics and different ways of stating the second law of thermodynamics with respect to its spontaneity. Spontaneous and non-spontaneous processes, concept of entropy and its significance.

Gibbs free energy: Work function, chemical potential, definition and relationship between free energy and work function. Criteria for equilibrium and spontaneous processes. Gibb's-Helmholtz equation (derivation-differential form). Rate of change of free energy with respect to temperature and pressure. Temperature coefficient, derivation of van't Hoff isotherm, $\Delta G^0 = - RT \ln (Kp)$.

van't Hoff reaction isochore (derivation): Clausius - Clapeyron equation (derivation), its applications in the determination of ΔT_b and ΔT_f (derivation not required),

Numerical problems.

Qualitative treatment of Nernst heat theorem and third law of thermodynamics (statement only). Concept of residual entropy.

Statistical thermodynamics: Limitations of classical thermodynamics and approach of non-classical thermodynamics. Maxwell-Boltzmann statistics, Bose-Einstein statistics, Fermi-Dirac statistics (expressions only).

Colligative Properties 5 h

Colligative properties – Definition, (a) Lowering of vapour pressure, Roult's law, (b) Osmotic pressure – osmosis, isotonic solutions. Laws of osmotic pressure – van't Hoff-Boyles law, van't Hoff-Charles law van't Hoff-Avogadro law, van't Hoff theory of dilute solutions, reverse osmosis, applications of osmosis (c) Elevation of boiling point, Determination of molar mass by Walker-Lumsden method. (d) depression of freezing point. Abnormal colligative behaviour, van't Hoff factor (*i*). numerical problems.

Unit-III

Electrochemistry 10 h

Electrochemistry – definition, conductance, conductors, differences between metallic and electrolytic conductors, conductivity cell, cell constant, conductivity. Specific, equivalent and molar conductivities and their variation with dilution for weak and strong electrolytes. Debye-Huckel theory of strong electrolytes – electrophoretic effect and relaxation effect/asymmetric effect; Kohlrausch's law of ionic conductance (problems). Transport number and its experimental determination by moving boundary

method, abnormal transport number, ionic mobility. Applications of conductivity measurements. Conductometric titrations and its advantages (only acid-base) SA vs SB; SA vs WB; WA vs SB and WA vs WB. .

Electrodes, types of electrodes, electrode potential, factors affecting electrode potential, standard electrode potential, IUPAC sign convention, Nernst equation (no derivation) and its significance, electrochemical series and its significance. Electrochemical cells, emf of a cell, measurement of emf of a cell, reversible and irreversible cells, standard cell (Weston cadmium cell), Calculation of equilibrium constant from EMF data (problems). Concentration cells, Liquid junction potential and salt bridge. Reference electrodes: Types – primary (Standard Hydrogen Electrode - construction, working and limitations) and secondary (construction and working of calomel, quinhydrone and glass electrodes), determination of pH using these electrodes. Potentiometric titrations (only qualitative treatment of acid-base and oxidation-reduction) and its advantages.

Solids 5 h

Forms of solids – isotropic and anisotropic, symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography – Law of constancy of interfacial angles, Law of rational indices, Law of symmetry. Representation of planes – Miller indices, Weiss indices – definition, procedure for its calculation, problems. X-ray diffraction by crystals, Bragg's law - derivation and numerical problems. Structures of NaCl by rotating crystal method.

Unit-IV

Carboxylic Acids 5 h

Methods of preparation. Reactions: Hell–Vohlard-Zelinsky Reaction, Decarboxylation, Hunsdiecker reaction, Arndt-Eistert homologation. Conversion of carboxylic acids into acid chlorides, anhydrides, esters and amides.

Acidity: Comparison of acidic strengths of (i) formic acid, acetic acid and propanoic acid (ii) flouro acetic acid, chloro acetic and bromo acetic acid (iii) *p-methoxybenzoic* acid, benzoic acid and *p*-nitro benzoic acid.

Dicarboxylic acids: Structures of dicarboxylic acids (from C_2 to C_7), Action of heat on dicarboxylic acids (Blanc's Rule).

Organic Compounds Containing Nitrogen

Nitro Compounds 2 h

Methods of preparation of nitroalkanes, reduction products of nitrobenzene in various media – (a) H_2/Pt , (b) Sn/Conc.HCl (c) Zn/NH_4Cl.

Amines 3 h

Methods of preparation. Basicity: Comparison of basic strengths of (i) primary, secondary and tertiary amines (ii) alkyl and aryl amines. Reactions: Carbylamine reaction, alkylation, Hofmann's elimination, reaction of alkyl amines with nitrous acid.

Diazotisation – Definition, preparation of benzene diazonium chloride (BDC), synthetic applications of BDC – Sandmeyer's reaction, reduction to phenyl hydrazine, coupling reaction.

Heterocyclic Compounds 5 h

Introduction, classification and nomenclature. Methods of preparation: Furan – from mucic acid, Thiophene – from acetylene, Pyrrole – from ammonium mucate, Pyridine – from acetylene. Aromaticity and basicity of pyrole and pyridine.

Reactions of furan, thiophene, pyrrole (electrophlic aromatic substitution reactions – nitration and Friedel-Craft's reaction with emphasis on regioselectivity), Nucleophilic aromatic substitution reaction of pyridine (Chichibabin reaction).

Quinoline – by Skraup synthesis; Indole – by Fischer Indole synthesis, Nitration of indole and quinoline with emphasis on regioselectivity.

References:

1. Inorganic Chemistry (4th edition): J.E Huheey, E.A Keiter and R.L. Keiter (1993); Harper Collins.
2. Introduction to modern inorganic chemistry (4th edition): K.M. Mackay and R.A Mackay (1989): Blackie.
3. Advanced Inorganic Chemistry (5th edition): F.A Cotton and G.Wilkinson (1990): Wiley.
4. Concise Inorganic Chemistry (5th edition): J.D. Lee (2000); Blackwell Science.
5. Concepts and Models in Inorganic Chemistry (3rd edition) B.E.Dougglas, D.H. Mc Daniel and Alexander. (2001): Wiley
6. Fundamentals Concepts of Inorganic Chemistry, Vols.1 and 2, Asim K. Das, CBS Publishers and Distributosr, 2nd Edn.
7. Inorganic Chemistry, Catherine E. Housecroft, A.G. Sharpe, Pearson Prentice Hall, 2nd edition (2005).
8. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
10. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
11. Text book of Organic chemistry - Jagdamba Singh, vol. I and II.
12. Advanced Organic Chemistry - Reactions, Mechanism and Structure, Jerry March, John Wiley (2008).
13. Advanced Organic Chemistry, F A Carey and R J Sundberg Plenum, (1990).
14. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman, (2000).
15. Atkin's Physical Chemistry, Peter Atkins, Julio De Paula, Oxford University Press, 8th edition (2006).
16. Elements of Physical Chemistry, Samuel Glasstone, David Lewis, Palgrave Macmillan, 2nd edition (1963).
17. A Text book of Physical Chemistry, A. S. Negi, S. C. Anand, New Age International Publishers (2007).
18. Principles of Physical Chemistry, Puri, Sharma, Pathania, Vishal Publishing Co., 47th edition (2020).
19. A Text Book of Physical Chemistry P. L. Soni, O. P. Dharmarha and, U. N. Dash, Sultan Chand and Sons (2016).
20. Advanced Physical Chemistry, Gurdeep Raj, Krishna Prakashan Media Publishers (2020).

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Chemistry Practicals-III 4 h/week

Part A

1. Determination of equivalent conductance of 0.1 N NaCl solution.
2. Determination of disassociation constant (pK_a) of weak acids by conductivity method.
3. Estimation of amount of HCl by conductometric titration with NaOH.
4. Conductometric titration of weak acid (CH_3COOH) versus weak base (NH_4OH).
5. Determination of pH of a buffer by using quinhydrone electrode.
6. Estimation of amount of ferrous ammonium sulphate by potentiometric titration using $K_2Cr_2O_7$.
7. Determination of standard electrode potential of $K_2Cr_2O_7$ / FAS system by potentiometric titration method.
8. Determination of isoelectric point of amino acid using pH meter.

Part B

1. Determination of equivalent weights of carboxylic acids by titration method.
2. Preparation of coumarin from ethyl acetoacetate and resorcinol (Pechman method).
3. Preparation of benzoic acid from toluene.
4. Preparation of para amino azobenzene (aniline yellow) by two step method (diazotization of aniline followed by coupling).

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Fourth Semester

Chemistry-IV 60 h

Course Objectives

1. To make students understand the general trends of transition elements, lanthanides and actinides.
2. To provide fundamental knowledge of properties of non-aqueous solvents and their typical reactions.
3. To familiarize understand the kinetics of chemical reactions.
4. To introduce phase diagrams and their interpretation.
5. To enable students understand the chemistry of natural products such as carbohydrates, alkaloids and terpenes.

Course Outcomes

At the end of the course, student will be able to,

1. Evaluate and compare the chemistry of transition, inner transition elements and main group elements.
2. Understand non-aqueous solvents and their typical reactions.
3. Understand the kinetics of chemical reactions.
4. Interpret of phase diagrams.
5. Write the structures of carbohydrates, alkaloids and terpenes.

Unit-I 15 h

Transition Elements (3d series) 8 h

General trends in electronic configuration, atomic/ionic radii. Characteristic features of transition elements – variable oxidation states (stability of various oxidation states – Latimer diagrams for Cr, Mn, Fe, Co, Ni, and Cu), formation of coloured compounds, formation of complex compounds, magnetic properties (paramagnetism, diamagnetism, and ferromagnetism, magnetic moment (μ) – definition and calculation of magnetic moment for various 3d series metal ions), catalytic properties (examples of reactions involving transition metal compounds as catalysts – V, Fe, Co and Ni).

Lanthanides: Electronic configuration, oxidation states, ionic radii, lanthanide contraction, causes and consequences of lanthanide contraction, color and spectra, magnetic properties, separation of lanthanides by ion exchange method.

Actinides: Electronic configurations, oxidation states, ionic radii, color and spectra, magnetic properties. Comparison of actinides with lanthanides.

Chemistry of Main Group Elements 4 h

Preparation, classification, structure and bonding in boranes (B_2H_6, B_4H_{10}, B_5H_9), carboranes ($C_2B_{10}H_{12}$, $C_2B_9H_{13}$, $C_2B_6H_{12}$) and Wade's rules. Preparation and structure of borazines, phosphazines, Silicones – preparation of linear polymer by hydrolysis of dialkyldichlorosilane, cross-linked polymer by hydrolysis of alkyltrichlorosilane, applications. S and N-compounds (S_2N_2 and S_4N_4).

Non-aqueous Solvents 3 h

Classification of solvents, properties of solvents (dielectric constant, donor and acceptor properties). Protic solvents – properties and typical reactions (anhydrous H_2SO_4 and glacial acetic acid), aprotic solvents – properties and typical reactions (liquid SO_2 and N_2O_4). Solutions of metals in liquid ammonia.

Unit-II 15 h

Chemical Kinetics 8 h

Concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Difference between order and molecularity. Derivation of rate equations for zero, first and second order reactions (both equal and unequal concentrations of reactants). Derivations of expressions for half-life of a reaction (zero, first and second order). Mean life period General methods for determination of order of a reaction - Integration method, half-life method, Ostwald's isolation method. Concept of activation energy and its calculation from Arrhenius equation, Numerical problems.

Theories of reaction rates: Collision theory, Activated Complex theory of bimolecular reactions and Lindemann's theory of unimolecular reactions.

Phase Equilibrium 7 h

Introduction. Definitions of phase, components and degrees of freedom of a system with examples, criteria of phase equilibrium, Statement of Gibb's phase rule and its thermodynamic derivation. Clausius-Clapeyron equation (no derivation) and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur), condensed phase rule. Pattison's process for desilverization of argentoferrous lead. Two-component systems involving eutectics and freezing mixtures and their applications.

Unit-III

Natural Products 15 h

Carbohydrates 9 h

Introduction and classification, structural elucidation of glucose, open chain and Haworth structures of glucose and fructose, mutarotation, ascending and descending synthesis of monosaccharides (Killiani-Fischer synthesis and Whol's method). Synthesis of amino sugars (beta-D-glucosamine, galactosamine, N-acetylmuramic acid (NAMA), N-acetyl neuraminic acid (NANA). C- and N- glycosides. Synthesis of aldonic, alduronic, aldaric acids and alditols

Structural elucidation of sucrose, glycosidic bond, Haworth structures of lactose, gentiobiose, meliobiose and raffinose. Partial structures of amylose, amylopectin and cellulose.

Alkaloids 3 h

Introduction and occurrence, general characteristics, structure and general physiological effects of ephedrine, coniine, caffeine and piperine, Hoffman exhaustive methylation, structural elucidation of nicotine and synthesis of nicotine from 3-cyanopyridine

Terpenes 3 h

Introduction, occurrence, classification with examples, Ingold's isoprene rule. Structural elucidation and synthesis of citral. Structures (showing isoprene units and linkages) and uses of limonene, menthol, camphor, beta-carotene and vitamin-A.

UNIT-IV

Analytical Chemistry 15 h

Fundamentals of Analysis 3 h

Basic concepts of analysis, determination, measurement, techniques and methods. Classification of analytical techniques. Method validation – Accuracy, precision, sensitivity, selectivity. Limit of Detection (LOD) and Limit of Quantification (LOQ).

Evaluation of Analytical Data 4 h

Errors: Determinate and indeterminate errors, absolute error, relative error, minimization of errors. Statistical treatment of finite samples –mean, median, range, standard deviation and variance, confidence limit, test of significance, rejection of a result, Q- Test. (Numerical problems)

Chromatography 8 h

General description of chromatography- classification, chromatograms, retention time, retention factor, capacity factor, selectivity factor. Column efficiency – plate theory and rate theory. Theory of zone broadening, Van Deemter equation, column resolution, variables affecting column resolution. Thin-layer Chromatography principle, methodology and applications. Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC),

References:

1. Inorganic Chemistry (4thedition): J.E Huheey, E.A Keiter and R.L. Keiter (1993); Harper Collins.
2. Introduction to Modern Inorganic Chemistry (4th edition): K.M. Mackay and R.A Mackay (1989): Blackie.
3. Advanced Inorganic Chemistry (5thedition): F.A Cotton and G. Wilkinson (1990): Wiley.
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16. Elements of Physical Chemistry, Samuel Glasstone, David Lewis, Palgrave Macmillan, 2nd edition (1963).
17. A Text book of Physical Chemistry, A. S. Negi, S. C. Anand, New Age International Publishers (2007).
18. Principles of Physical Chemistry, Puri, Sharma, Pathania, Vishal Publishing Co., 47th edition (2020).
19. A Text Book of Physical Chemistry P. L. Soni, O. P. Dharmarha and, U. N. Dash, Sultan Chand and Sons (2016).
20. Advanced Physical Chemistry, Gurdeep Raj, Krishna Prakashan Media Publishers (2020).
21. Instrumental Methods of Chemical Analysis by Gurudeep R Chatwal and Sham K Anand, Himalaya Publishing House.

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Chemistry Practicals-IV 4 h/week

Part A

Semi-micro qualitative analysis of inorganic salt mixtures containing two anions and two cations.

The following cations and anions are to be identified:

Cations: NH_4^+, Pb^{2+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, Na^+ and K^+.

Anions: CO_3^{2-}, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, SO_4^{2-}, $C_2O_4^{2-}$ and PO_4^{3-}

Spot tests and flame tests to be carried out wherever possible.

Part B

1. Determination of rate constant of acid hydrolysis of methyl acetate (Titrimetric method).
2. Separation of amino acids by paper chromatography.
3. Determination of molecular weight of non-volatile solids by ebullioscopic method.
4. Qualitative analysis of carbohydrates (reducing and non-reducing sugars, monosaccharides, disaccharides and polysaccharides)

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Discipline Core Elective Paper for Third Semester

Industrial Chemistry 45 h

Course Objectives

1. Comprehend the theory of color and constitution and how structural changes affect color properties.
2. Understand the chemical structures and uses of major pharmaceutical compounds
3. Provide fundamental knowledge of inorganic industrial materials and their industrial applications
4. Introduce the composition, types, manufacturing, and properties of glass, cement, ceramics, and abrasives.
5. Provide knowledge about the classification and industrial significance of both ferrous and non-ferrous alloys.
6. Explain the importance of food preservation, the science behind it, and its application in producing common preserved products.

Course Outcomes

At the end of the course, student will be able to

1. Classify different types of drugs used in chemotherapy and describe their functions.
2. Define and classify synthetic dyes, chromophores, and auxochromes with relevant examples.
3. Discuss the chemistry and preparation of selected explosives.
4. Classify fertilizers based on nutrient content.
5. Evaluate the composition and function of paints and pigments.
6. Evaluate the composition and nutritional value of preserved food products.

Unit-I 15 h

Organic Industrial Materials

Synthetic Dyes: 7 h

Introduction – definition, conditions, classification, chromophores, auxochromes – definition, examples. Theory of colour and constitution. Structure, synthesis and uses of the following dyes i) methyl orange ii) congo red iii) malachite green iv) phenolphthalein v) alizarin vi) indigo.

Drugs 8 h

Introduction, Chemotherapy - definition, classification of drugs with examples. i) antipyretics, ii) analgesics, iii) antibacterial drugs, iv) antimalarial drugs, v) antibiotics vi) antiseptics vii) hypnotics Structure and uses of i) paracetamol ii) sulphanilamide iii) aspirin, iv) chloroquine, v) dettol (major component only), vi) pencillin-V, vii) barbituric acid. Synthesis of selected drugs – paracetamol, aspirin, barbituric acid and dichlofenac.

Unit-II 15 h

Inorganic Industrial Materials

Glass: Introduction, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: (i) soda lime glass (ii) lead glass (iii) safety glass (iv) borosilicate glass (v) coloured glass (vi) photosensitive glass.

Cement: Introduction, classification of cement, raw materials and their role. Manufacture of cement and the setting process (quick-setting cement).

Ceramics: Importance of clays and feldspar. Ceramics: types and manufacture. High-technology ceramics and their applications, superconducting and semiconducting oxides, fullerenes, carbon nanotubes, and carbon fiber.

Abrasives: definition, classification, preparation of silicon carbide.

Fertilizers: Definition, types of fertilizers (N-type, P-type, K-type and mixed fertilizers), examples for NP, PK, KN, NPK fertilizers. Preparation of urea, ammonium nitrate, calcium ammonium nitrate and calcium superphosphate.

Chemical Explosives: Origin of explosive properties in organic compounds, preparation and explosive properties of lead azide, PETN, cyclonite(RDX). Introduction to rocket propellants.

Unit-III 15 h

Other Industrial Materials

Surface Coatings 5 h

Objectives of surface coatings, preliminary treatment of surface, classification of surface coatings. Paints and pigments: composition and properties (brief mention of oil paints, toners, fillers, thinners, enamels, emulsifying agents), eco-friendly paints and plastic paints.

Alloys 5 h

Classification of alloys, ferrous alloy with examples and their uses (ferrosilicon, ferrochrome, ferromanganese) and their uses. Non-ferrous alloys with examples and their uses [Copper alloys (bronze, brass), tin alloys (solder), gold alloy (Karat gold for jewelry)]. Composition and properties of different types of Steels (stainless steel, Nickel steel, Invar steel, chrome steel and manganese steel).

Food Preservatives 5 h

Definition, objectives and principles of food preservation. Different methods of food preservation. Preserved Products (jam, jelly, sauces, pickles, squashes: composition, storage, uses and their nutritional aspects).

Recommended Books/References:

1. Introduction to Industrial Chemistry, Howard L. White, Wiley Interscience Publisher, 1st edition (1986).
2. Industrial Chemistry, Vols I and II, B.K. Sharma, Krishna Prakashan Media Pvt. Ltd., (2016).
3. Engineering Chemistry, B. K Sharma, Krishna Prakashan Media Pvt. Ltd., (2014).
4. Engineering Chemistry, R.Gopalan, D.Venkapayya, S.Nagarajan.Vikas Publn, New Delhi, 4th Edn (2018).
5. Engineering Chemistry, P.C. Jain, M. Jain. Dhanpath Rai and Sons, Delhi, 17th edition (2015).
6. Riegel's Handbook of Industrial Chemistry, J. A. Kent, Springer, 10th edition (2003).
7. Introduction to Ceramics, W. D. Kingery, H. K. Bowen, D. R. Uhlmann, Wiley Publishers, 2nd edition (1976).
8. Industrial Chemistry, E. Stocchi, Vol-I, Ellis Horwood Ltd, UK (1990).

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Discipline Core Elective Paper for Fourth Semester

Water Analysis and Treatment Techniques. 45 h

Course Objectives

1. Understand water fundamentals: Properties, hydrologic cycle, and resources.
2. Assess and analyze water quality: Key parameters, Indian standards, and practical analysis skills.
3. Identify and sample pollutants: Sources, impacts, and basic collection/preservation.
4. Apply pollution indicators: Determine and interpret DO, BOD, COD, and understand health significance.
5. Learn wastewater treatment: Principles of preliminary to advanced processes.
6. Manage sludge and promote reuse: Sludge treatment, disposal, wastewater reuse, and bioremediation.

Course Outcomes

At the end of the course, student will be able to

1. Understand water: Properties, hydrologic cycle, and distinguish polluted from unpolluted water using Indian standards.
2. Analyze water quality: Perform lab tests for key parameters like solids, hardness, and heavy metals.
3. Identify pollutants & sample: Recognize pollutants, their impacts and apply proper sampling techniques.
4. Interpret pollution indicators: Determine and explain DO, BOD, COD, and health risks from heavy metals.
5. Grasp waste water treatment: Explain treatment technologies from preliminary to tertiary stages.
6. Manage water resources: Describe sludge management, wastewater reuse and bioremediation.

Unit-I: Introduction 15 h

Structure and anomalous properties of water. Water as universal solvent. Reaction of water with metals and non-metals.

Water Resources and Properties: The hydrologic cycle. Unpolluted vs polluted water, complexation in natural water and waste water, water quality parameters – standards in India. Physical properties of domestic water – colour, odour, pH, turbidity and hardness, TDS.

Water Analysis: Determination of total solids, acidity, alkalinity, total hardness, fluoride and chloride content, iron content, microbial content, heavy metals.

Unit-II: Water Pollution 15 h

Origin of waste water, types of water pollutants of their sources and effects. Major pollutants such as pathogens, organic wastes and chemical pollutants; their harmful effects and prevention. Sample collection and preservation. Determination of DO, BOD and COD. Heavy metal pollution-public health significance of Pb, Cd, Hg, As. Environmental and public health significance: Health disorders originating from water pollution. Acid rain, organic pollutants, radioactive pollutants, forever chemicals, bioaccumulation.

Unit-III Waste Water Treatment 15 h

Waste water characteristics, effluent standards, terminology in waste water treatment.

Treatment of domestic waste water–preliminary treatment. Primary treatment: sedimentation, equalization, neutralization. Secondary treatment: Aerated lagoons, trickling filters, activated sludge process, oxidation ditch, oxidation pond and anaerobic digestion. Sludge treatment and disposal. Tertiary treatment: evaporation, ion-exchange, adsorption, electrodialysis, electrolytic recovery and reverse osmosis. Advanced waste water treatment: nutrient removal–nitrogen and phosphorus removal, solids removal. Waste water disposal and reuse. Bioremediation.

Recommended Books/References:

1. Concise Inorganic Chemistry, J. D. Lee, Blackwell Science, London, 5th edition (2010).
2. Principles of Inorganic Chemistry, B. R. Puri, L. R. Sharma, K. C. Kalia, Vishal Publishers, 33rd Edn (2020).
3. Environmental Chemistry, A. K. De, New Age International Ltd, 1st edition (2016).
4. Environmental Science, T. G. Miller Jr., Brooks/Cole Publisher, Meerut, 13th edition (2009).
5. Fundamentals of Ecology, E. P. Odum, W.B. Saunders Co., Philadelphia, 3rd edition (1971).
6. Environmental Chemistry, S. E. Manahan, CRC Press, 10th edition (2017).
7. Environmental Chemistry, Sharma and Kaur, Pragathi Praksahan (2010).
8. Environmental Pollution: Monitoring and control, S.M. Khopker, New Age International (2007).
9. Environmental Chemistry, C. Baird, M. Cann, W. H. Freeman publication, 5th edition (2012).
10. Fundamental Concepts of Environmental Chemistry, G. S. Sodhi, Narosa Publishers, 3rd edition, (2009).
11. Principles of Instrumental Analysis, D. A. Skoog, Sauns College Publishing (London), 6th edition (2007).
12. Basic Concepts of Analytical Chemistry, S. M. Khopkar, New Age International Pvt. Ltd, 2nd edition (2004).

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Examination Pattern

Core Papers (III and IV Semester B.Sc.)

Theory: 4 Credits : 100 Marks

[Summative Assessment (SA) - 80 Marks + Internal Assessment (IA) - 20 Marks]

Practicals: 2 Credits : 50 Marks

[Summative Assessment (SA) - 40 Marks + Internal Assessment (IA) - 10 Marks]

CREDITS: Lecture (L) + Practical (P) (4:2)	**THEORY**	**PRACTICALS**	**TOTAL**
	Maximum Marks (M)		
Internal Assessment (IA)	**20** Average of two Tests (10) + Average of two Assignments (10)	**10** 1 Test (5) 1 Assignment (5)	**30**
Summative Assessment (SA)	80	40	**120**
Duration of End Semester Examination	3 hours	3 hours	
Maximum Marks	**100**	**50**	**150**

Open Elective Papers (III and IV Semester B.Sc.)

Theory: 3 Credits: 100 Marks

[Summative Assessment (SA) - 80 Marks + Internal Assessment (IA) - 20 Marks]

CREDITS: Lecture (L) (3)	**THEORY**	**TOTAL**
Internal Assessment (IA)	**20** Average of two Tests (10) + Average of two Assignments (10)	**20**
Summative Assessment (SA)	80	**80**
Duration of End Semester Examination	3 hours	-
Maximum Marks	**100**	**100**

Blue Print of Question Papers for Examination and Evaluation

Core Papers (III and IV Semester B.Sc.,)

Theory

Duration: 3 Hours	**The question paper shall consist of two parts: Part A and Part B**	**Max Marks: 80**
Part A	Answer any 10 out of 12 questions [Q 1 to Q 12] **(three questions from each unit)**	10 × 2 = 20
Part B	Answer any 6 out of 8 questions [Q 13 to Q 20] **(two questions from each unit)**	6 × 10 = 60
i) Equal weightage of marks shall be given to all the units in Part A and Part B. ii) In part B, each main question shall have only three sub-divisions (a), (b) and (c) with (4+4+2) or (4+3+3) marks respectively.		

Practical

Duration: 3 Hours	**Max. Marks: 40**
Performance	**30 marks** Two experiments: One from part-A and one from part-B
Viva	**5 marks**
Record	**5 marks** (minimum 8 experiments to be recorded)

Discipline Core Elective Papers (III and IV Semester B.Sc.,)

Theory

DURATION: 3 Hours	**The question paper shall consist of two parts: Part A and Part B**	**Max. Marks: 80**
Part A	Answer any 10 out of 12 questions [Q 1 to Q 12] **(four questions from each unit)**	10 × 2 = 20
Part B	Answer any 6 out of 9 questions [Q 13 to Q 21] **(three questions from each unit)**	6 × 10 = 60
i) Equal weightage of marks shall be given to all the units in Part A and Part B. ii) In part B, each main question shall have only three subdivisions (a), (b) and (c) with (4+4+2) or (4+3+3) marks respectively.		