

RTM, NAGPUR UNIVERSITY, NAGPUR
SEMESTER PATTERN (CBS) SYLLABUS

SUBJECT: CHEMISTRY

B.Sc. III Semester - V

CH- 501 : Paper - I (Organic Chemistry)

(To be implemented from academic session 2022-2023)

UNIT-I

(7.5 Hrs)

(A) Organic compounds of Nitrogen: Preparation of nitroalkanes from alkanes, alkyl halides and oximes. Chemical reactions of nitroalkanes: Reduction, hydrolysis, halogenation, action of heat, reaction with nitrous acid. Physical properties of nitroalkanes. Preparation of nitroarenes from benzene. Chemical reactions of nitroarenes: Electrophilic substitution, nucleophilic substitution, reduction reaction (acidic medium, neutral medium, alkaline medium, catalytic reduction). Physical properties of nitroarenes. Mechanism of nucleophilic substitution in nitrobenzene. Picric acid-preparation and uses.

(B) Amines: Classification, nomenclature, structure and physical properties of amines, Stereochemistry of amines, Separation of mixture of 1°, 2° and 3° amines by Hoffmann's method and Hinsberg's method. Basicity of amines: Effect of substituents on basicity of aromatic amines. Preparation of alkyl & aryl amines (reduction of nitro compounds and nitriles), Gabriel phthalimide reaction, Hoffmann bromamide reaction, Reactions of amines (carbylamine reaction, alkylation, acylation, with Grignard reagent), Preparation and synthetic transformations of aryl diazonium salts.

UNIT-II: Heterocyclic Compounds

(7.5 Hrs)

(A) Molecular orbital picture and aromaticity of furan, thiophene, pyrrole and pyridine. Methods of preparation of pyridine from (i) acetylene, (ii) hexamethylenediamine (iii) β -Picoline and (iv) pyrrole. Chemical reaction of pyridine: reduction, electrophilic substitution reactions, nucleophilic substitution reactions, oxidation. Structure of pyridine. Comparison of basicity of pyrrole and pyridine.

(B) Introduction to condensed five and six membered heterocyclic compounds. Preparation and reactions of Indole, Quinoline and Isoquinoline with special reference to Fischer Indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis.

UNIT-III

(7.5 Hrs)

(A) Quantitative Analysis: Estimation of carbon, hydrogen, nitrogen, sulphur and halogens (only principles and calculations). Calculation of Empirical and molecular formula with numericals.

(B) Organometallic compounds: Organomagnesium compound (Grignard reagent): Preparation from alkyl and aryl halides. Chemical reactions: reaction with ether, water, alcohols, ammonia, carbon dioxide, chloramine. Structure of Grignard Reagent. Organozinc compounds: Preparation from alkyl iodide. Chemical reactions with acetyl chloride, water, alcohols and aldehydes. Reformatsky reaction. Organolithium compounds: Preparation from alkyl and aryl halides, by metal-metal exchange. Chemical reactions: reaction with formaldehyde, dry ice, epoxide, alkenes and methyl cyanide.

UNIT-IV- Spectroscopy

(7.5 Hrs)

(A) Electromagnetic Spectrum: Absorption spectra, Ultraviolet absorption spectroscopy, Absorption laws (Beer-Lambert law), Molar absorptivity, Presentation and analysis of UV spectra, Types of electronic transitions, Effect of conjugation, concept of Chromophores and Auxochromes, Bathochromic, Hypsochromic, Hyperchromic and Hypochromic shifts. UV spectra of conjugated dienes and enones.

(B) Pharmaceutical Chemistry Introduction and synthesis of drugs:

Antiviral drugs (Synthesis of Zidovudine), Antibacterial drugs (Synthesis of Sulpha methoxazole), Anticancer drugs (Synthesis of Melphalan), Cardiovascular drugs (Synthesis of Isosorbide di-nitrate), Antihypertensive drugs (Synthesis of Verapamil)

Reference Books:

1. Principles of Medicinal Chemistry- Kadam S. S.
2. Medicinal Chemistry- Chatwal G. R.
3. Medicinal Chemistry- Ahluwalia V. K.
4. Medicinal Chemistry- Gupta A. L.
5. Medicinal Chemistry- Sriram D. and Yogeeswari P.
6. Elementary Organic Spectroscopy, Principles and Chemical Applications, S. Chand Publication, Y. R. Sharma
7. Organic Chemistry, Volume 1, The Fundamental Principles, I. L. Finar
8. A Text Book of Organic Chemistry, Narosa publication, V. K. Ahluwalia and Madhuri Goyal

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SEMESTER PATTERN (CBS) SYLLABUS

SUBJECT: CHEMISTRY

B.Sc. III Semester - V

CH- 502 : Paper - II (Physical Chemistry)

(To be implemented from academic session 2022-2023)

UNIT – I : Electrochemistry

7.5 Hrs.

(A) Galvanic cells, Reversible and irreversible cells, EMF of cell and its measurement Standard cell, Relation between electrical energy and chemical energy, Calculation of thermodynamics quantities of a cell reactions (ΔG , ΔH , ΔS , & equilibrium constant)

Determination of ΔG^0 , ΔH^0 & ΔS^0 of a cell reaction. Types of reversible electrodes: Metal-metal ion electrodes, Amalgam electrodes, Gas electrodes, Metal- metal insoluble salt- salt anion electrodes, Redox electrodes. Numerical problems.

(B) Nernst equation for EMF of a cell, Single electrode potential, Calculation of cell EMF from single electrode potential, Reference electrodes, Standard electrode potential, Concentration cells with and without transference, Liquid junction potential, Salt bridge & its function. Fuel cells : Hydrogen-oxygen fuel cell, Hydrocarbon-oxygen fuel cell, Coal-fired fuel cell and Hydrogen-oxygen fuel cell in manned space flights. Application of EMF measurements in : (i) pH determination using hydrogen electrode, quinhydrone electrode and glass electrode (ii) Potentiometric titrations (Acid-base, Redox and Precipitation titrations). Numerical problems.

UNIT – II -: Quantum Chemistry

7.5 Hrs.

(A) Application of Schrodinger wave equation in One dimensional box, Three dimensional box, Explanation of degeneracy, Schrodinger wave equation for hydrogen atom in polar co-ordinates, Separation of Schrodinger wave equation for hydrogen atom into three variables, Hydrogen like atoms (without derivation), Concept of orbital, Shapes of orbitals, Radial probability distribution curves for 1s, 2s, 2p, 3p and 3d orbitals. Numerical problems.

(B) Molecular Orbital Theory : Born-oppenheimer approximation, Criteria for forming MO's from AO's, LCAO- H_2^+ ion, Physical picture of bonding and anti-bonding wave functions, Comparison of bonding and antibonding molecular orbitals, Variation of electron probability density along internuclear axis in bonding and antibonding molecular orbitals, Concept of σ , σ^* , π , π^* orbitals and their characteristics, Valence bond theory and molecular orbital theory, Comparison of valence bond and molecular orbital models. Numerical problems.

UNIT – III -: Photochemistry and Raman Spectroscopy

7.5 Hrs.

(A) Photochemistry : Interaction of radiation with matter, Difference between thermal and photochemical reactions, Laws governing absorption of light, Laws of photochemistry, Jablonski diagram depicting various processes, Quantum yield, Determination of quantum yield of reactions, Reasons for low and high quantum yield, Some examples of photochemical reactions (e.g. photochemical decomposition of HI, photosynthesis of HBr, photosynthesis of HCl). Photosensitization, Photosensitized reactions. Numerical problems

(B) Raman Spectroscopy : Raman effect, Explanation of Rayleigh's line, Stokes' lines anti-Stokes' lines. Experimental set up of Raman spectrophotometer. Pure rotational Raman spectra of diatomic molecules, Rotational-Vibrational Raman Spectra of diatomic molecules, Advantages of Raman spectroscopy over Infra-red spectroscopy. Numerical problems.

UNIT – IV -: Colligative Properties and Macromolecules

7.5 Hrs.

(A) Colligative Properties : Methods of expressing concentration of solutions, Raoult's law, Relative lowering of vapour pressure, Determination of molecular mass from relative lowering of vapour pressure, Osmosis and Osmotic pressure of solution, Measurement of osmotic pressure by Berkeley and Hartley method. Determination of molecular mass from osmotic pressure. Elevation of boiling point of solvent, Determination of molecular mass from elevation of boiling point. Depression of freezing point of the solvent. Determination of molecular mass from depression of freezing point. Van't Hoff factor, Degree of association and dissociation of solute. Numerical problems.

(B) Macromolecules : Macromolecules, Classification of polymers, Molar masses of polymers : Number average and Weight average molar masses, Determination of molar masses of macromolecules : Viscometry, Osmometry and Light Scattering methods. Electronically conducting polymers : Poly (acetylene), Poly (sulphur-nitride), Poly (para-phenylene), Poly (aniline). Numerical problems.

Reference Books :

1. Barrow G. M., Physical Chemistry, Tata McGraw Hill (2007).
2. Castellan G. W., Physical Chemistry, Narosa (2004).
3. Prasad R. K., Quantum Chemistry, Wiley. Eastern Ltd, New Delhi (1992).
4. Puri B. R. Sharma L.R. Pathania M. S., Principles of Physical Chemistry, Vishal Publication Co. (2018).
5. Kapoor K. L., Physical Chemistry, Vols. I, II, III & IV, Macmillan (India) Ltd. New Delhi (1984)

CH- 503 : Laboratory Course

Practical - I (Organic Chemistry)

- Estimations
- (i) Estimation of Glucose
 - (ii) Estimation of Amide
 - (iii) Estimation of Nitro group
 - (iv) Estimation of Carboxylic group
 - (v) Saponification of oil

Reference Books :

1. Chemistry for Degree Students, B. Sc. Second Year, S. Chand Publication, Dr. R. L. Madan

Practical – II (Physical Chemistry)

1. To determine the strength of given acid (HCl or CH₃COOH) potentiometrically using standard alkali solution.
2. To determine dissociation constant of weak acid potentiometrically by titrating its against alkali.
3. To titrate potentiometrically ferrous ammonium sulphate against potassium dichromate and calculate redox potential of Fe²⁺ / Fe³⁺ system.
4. To verify Beer's-Lambert law using calorimeter and determine the concentration of given solution.
5. To determine the molecular mass of non-volatile solute by Rast's method.
6. To determine the molecular weight of polymer by Viscometric method.
7. To determine the specific rotation of a given optically active compound and the concentration of an unknown solution Polarimetrically.
8. To study the rate of acid catalysed iodination of acetone.

Reference Books :

1. Das R. C. and Behra B., Experimental Physical Chemistry Tata McGraw Hill.
2. Yadav J. B., Advanced Practical Physical Chemistry, Goel Publishing House.
3. Jahagirdar D. V., Experiments in Chemistry, Himalaya Publishing House.

RTM, NAGPUR UNIVERSITY, NAGPUR

SEMESTER PATTERN (CBS) SYLLABUS

SUBJECT: CHEMISTRY

B.Sc. III Semester - VI

CH- 601 : Paper - I (Inorganic Chemistry)

(To be implemented from academic session 2022-2023)

Unit I:

(7.5 Hrs)

A) Metal ligand bonding in Transition Metal Complexes: Limitations of Valence bond theory, Crystal field theory: Splitting of d-orbital in octahedral, tetrahedral and square planar complexes. Factors affecting the Magnitude of $10 Dq$. Concept of Crystal field Stabilization Energy of octahedral and tetrahedral complexes. High spin low spin complexes on the basis of Δ_o and pairing energy in octahedral complexes. (Numericals)

B) Electronic spectra of Transition Metal Complexes:

Jahn-Teller Effect, Conditions of distortion with respect to CFT configuration. Selection Rules (Laporte and Spin selection Rules). Hole Formalism Principle with respect to d^1 and d^9 ions. Electronic spectrum of $[Ti(H_2O)_6]^{3+}$ and $[Cu(H_2O)_6]^{2+}$ complex ions with respect to position of the band, intensity of the band, symmetry of the band and bandwidth.

Unit-II:

(7.5 Hrs)

A) Magnetic Properties of Transition Metal Complexes:

Method of determination of Magnetic Susceptibility by Gouy's Method. Spin only formula and orbital contribution to magnetic moment. Magnetic properties of Octahedral and Tetrahedral complexes with respect to CFT. Numericals on magnetic moments.

B) Thermodynamic and Kinetic aspect of metal complexes:

Thermodynamic and Kinetic stability of metal complexes, their relation. Stepwise stability and overall stability constant and their relationship, Factors affecting the Stability of complexes. Determination of composition of Fe (III)-SSA complex by Mole Ratio and Job's Method.

Unit III:

(7.5 Hrs)

A) Organometallic Chemistry

Definition, Nomenclature and Classification of Organometallic compounds. Preparation properties and application of Alkyl and Aryls of Li and Al. A brief account of metal ethylenic complexes (Structure only). Homogeneous Hydrogenation (Wilkinson's Catalyst reaction).

B) Metal carbonyls

Definition, preparation, properties. Structure and bonding in mononuclear carbonyls- $Ni(CO)_4$, $Fe(CO)_5$ and $Cr(CO)_6$ with respect to back π -bonding.

Unit –IV:**(7.5 Hrs)****A) Bioinorganic Chemistry:**

Essential and Trace elements in biological processes, Metalloporphyrins with special reference to structure and role of Hemoglobin and Myoglobin in transport of Oxygen. Biological role of Na⁺ and K⁺ and Ca²⁺ metal ions. Sodium and potassium pump. Hypo and hyper calcimia. Hard and Soft Acids and Bases: Classification of Acids and Bases as Hard and Soft. Pearson's HSAB Concept and its applications. Symbiosis, Antagonism.

B) Nano chemistry: Introduction to Nano chemistry, Nanoparticles, Difference between Nano and Bulk materials. Synthetic approach for Nano materials: top-down and bottom-up approach, Different Methods for Synthesis of Nanomaterial: Sol-gel, Precipitation, Hydrothermal, Microwave, Sonication and Biogenic Synthesis, Characterization techniques for Nano materials. (Introduction to FT-IR, XRD, SEM, TEM, UV-DRS, BET, AFM), Nano composites and their types, Applications of Nano materials and Nano composites

References:

1. Concise Inorganic Chemistry-J. D. Lee; Backwell Publication
2. Modern Inorganic Chemistry- R. D. Madan ; S. Chand
3. Selected Topics in Inorganic Chemistry; W. U. Malik, G. D. Tuli, R. R. Madan ; S. Chand
4. Chemistry for Degree Students- R. D. Madan ; S. Chand
5. Advanced Inorganic Chemistry- Cotton and Wilkinson
6. Organometallic Chemistry – Mehrotra and Singh
7. Quantitative Analysis – Day and Underwood
8. Principles of Inorganic Chemistry- Puri, Sharma , Kalia
9. Textbook of Quantitative Chemical Analysis-Vogel
10. An Introduction to Nanomaterial and nanoscience- Asim K. Das and Mahua Das
11. Nanostructure and Nanomaterials- M. Balkrishnarao, K. Krishnareddy

RTM, NAGPUR UNIVERSITY, NAGPUR
SEMESTER PATTERN (CBS) SYLLABUS

SUBJECT: CHEMISTRY

B.Sc. III Semester - VI

CH- 602 : Paper - II (Organic Chemistry)

(To be implemented from academic session 2022-2023)

UNIT- I

(7.5 Hrs)

(A) Nuclear Magnetic Resonance (NMR) Spectroscopy

Principle, Nuclear shielding and deshielding, Chemical shift, Spin-spin splitting and Coupling constant. Interpretation of NMR spectra of organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,2 dibromoethane, ethyl acetate, toluene, acetophenone. Problem pertaining to the structure elucidation of simple organic molecules by NMR technique.

(B) Infrared (IR) Spectroscopy

Molecular vibrations, Hook's law, Selection rules, Intensity and position of IR bands, measurement of IR spectrum. Fingerprint region, characteristic absorptions of various functional groups and application of IR spectra.

UNIT- II

(7.5 Hrs)

(A) Organic Synthesis Via Enolates

Malonic Ester: Preparations, reactions, acidity of α -hydrogen atoms and reactivity of methylene group in malonic ester.

Acetoacetic Ester: Synthesis by Claisen condensation reactions, acidity of α -hydrogen atoms and reactivity of methylene group in acetoacetic ester. Keto-Enol Tautomerism of acetoacetic ester. Preparation of acetic acid, succinic acid, crotonic acid and heterocyclic compounds.

(B) Carbohydrates

Definition, classification and reactions of glucose. Mechanism of osazone formation. Determination of structure of glucose. Epimerisation, mutarotation, conversion of glucose into fructose and vice-versa. Chain lengthening and shortening of aldoses (Wohl's and Ruff's degradation). Introduction to structures of maltose, sucrose, lactose, starch, cellulose, ribose and deoxyribose.

UNIT-III

(7.5 Hrs)

(A) Amino Acids, Peptides, Proteins & Nucleic Acids

Classification and structure of amino acids. Acids base behavior, isoelectric point and electrophoresis. Structure and nomenclature of peptides and proteins. Classification, denaturation, structure determination of proteins (primary and secondary).

Nucleic Acids: Introduction, constituents of nucleic acids. Ribonucleosides and Ribonucleotides. Double helical structure of DNA.

(B) Fats, Oils, Soap and Detergents

Introduction of Natural fats and oils, industrial oils of vegetable origin, physical properties and difference between fat and oil, hydrogenation of unsaturated oils, Definition: Saponification value, Iodine value and Acid value. Preparation and cleansing action of Soaps, preparation of synthetic detergents, comparison of synthetic detergent and soap.

UNIT-IV

(7.5 Hrs)

(A) Synthetic Dyes

Colour and constitution (Witt theory, Electronic concept), Classification of Dyes based on chemical constitution. Preparation and uses of Congo red, Crystal violet, Phenolphthalein and Alizarin dye.

Synthetic Polymers: Introduction, homopolymers and copolymers (definition and example), Classification of polymers (natural and synthetic). Reaction of addition or chain growth polymerization, Reaction of condensation or step growth polymerization (Polyesters and polyamides). Free radical mechanism of vinyl polymerization, Ziegler-Natta polymerization.

(B) Green Chemistry

Introduction, Definitions and Principles of green chemistry, green solvents, Green Chemistry catalysis and alternative sources of energy, need and goal of green chemistry, Limitations of Green Chemistry.

Reference Books:

1. Ahluwalia, V.K. & Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers (2005).
2. Anastas, P.T. & Warner, J.K.: Green Chemistry - Theory and Practical, Oxford University Press (1998).
3. Gurtu J. N. and Sharma Kusum, Green Chemistry, Pragati Prakashan (2019)
4. K.R. Desai, Bhavanaben D. Mistry and Tarulata N.Chhowala, Green Chemistry Twelve Principles, Himalaya Publication (2018)
5. Elementary Organic Spectroscopy, Principles and Chemical Applications, S. Chand Publication, Y. R. Sharma
6. Organic Chemistry, Volume 1, The Fundamental Principles, I. L. Finar
7. A Text Book of Organic Chemistry, Narosa publication, V. K. Ahluwalia and Madhuri Goyal

CH-603: Laboratory Course

Practical - I (Inorganic Chemistry)

A) Gravimetric Analysis

- i) Estimation of Ba^{2+} as BaSO_4 ,
- ii) Estimation of Ni^{2+} as $\text{Ni}(\text{DMG})_2$ complex.

B) Colorimetry

- i) Colorimetric or spectrophotometric estimation of copper (II) in commercial copper sulphate sample as ammonia complex.
- ii) Jobs method of determination of composition of Fe- SSA complex
- iii) Mole Ratio Method of determination of composition of Fe- SSA complex

Practical – II (Organic Chemistry)

Separation of an organic mixture containing two solid components using NaOH / NaHCO_3 for separation, identification of the components and preparation of suitable derivatives (minimum five mixtures)

Reference Books:

1. Chemistry for Degree Students, B. Sc. Third Year, S. Chand Publication, Dr. R. L. Madan
2. A Laboratory Hand –Book of Organic Qualitative Analysis and Separations, V.S.Kulkarni
3. Textbook of Quantitative Chemical Analysis-Vogel