Vivekanand Education Society's College of Arts, Science, and Commerce (Autonomous)

Sindhi Society, Chembur, Mumbai, Maharashtra – 400 071.

Accredited by NAAC "A Grade" in 3rd Cycle - 2017
Best College Award—Urban Area, University of Mumbai (2012-13)
Recipient of FIST Grant (DST) and STAR College Grant (DBT)

Affiliated to the

University of Mumbai

Credit-Based System for Holistic Development

Syllabus for Program: B.Sc. (with Chemistry as Major)

As per NEP-2020, with effect from Academic Year 2025-2026,
T.Y.B.Sc. Chemistry NEP-2020 Course Structure for Academic Year 2025-26

T.Y.B.Sc. NEP-2020 Course Structure for Academic Year 2025-26

MAJOR COURSE:

Choose any ONE of the following

Major subjects
Physics
Chemistry
Microbiology

Detailed Course Structure (Circular based on 20th April 2023)

Semester - V		
Major Subject	**Chemistry**	**Credits**
Major Core Papers (Compulsory)	Chemistry Paper1 (Physical and Analytical Chemistry I)	**2**
	Chemistry Paper 2 (Inorganic Chemistry)	**2**
	Chemistry Paper 3 (Organic chemistry I)	**2**

	Chemistry Practical based on Paper 1, Paper 2 & paper 3	**4**
Elective Theory (related to Core Subject)	1. Tools & Techniques in Chemistry 2. Drugs & Dyes	**2**
Elective Practical (related to Core Subject)	**Practical based on:** 1. Tools & Techniques in Chemistry 2. Drugs & Dyes	**2**

Vocational Skill Course (VSC)	**Industrial Manufacturing process (Practical)**	**2**
Minor Subjects (Theory)	Microbiology (Biomolecules) OR Physics (Nuclear Physics and Digital Electronics) OR Mathematics (Linear Algebra II)	**2**

Minor Subjects (Practical)	Microbiology Practicals based on Biomolecules OR Physics (Nuclear Physics and Digital Electronics) OR Mathematics Practical Based on Minor	**2**
Field Project (FP)		**2**
Total		**22**

Detailed Course Structure

Semester - VI		
Major Subject	**Chemistry**	**Credits**
Major (Core) Papers (Compulsory)	Chemistry Paper 1 (Physical and Analytical Chemistry II)	**2**
	Chemistry Paper 2 (Inorganic Chemistry II)	**2**
	Chemistry Paper 3 (Organic Chemistry II)	**2**
	Chemistry Practical based on Paper 2, & Paper 3	**4**
Elective (related to Core Subject)	1. Tools & Techniques in Chemistry 2. Drugs & Dyes	**2**

Elective (related to Core Subject)	**Practical based on** 1. Tools & Techniques in Chemistry 2. Drugs & Dyes	**2**
Minor Subjects (Theory)	Microbiology (Basic Techniques in Microbiology) **OR** Physics (Electronics And Radiation Physics) **OR** Mathematics (Calculus II)	**2**

Minor Subjects (Practical)	Microbiology practicals based on Minor **OR** Physics ((Electronics And Radiation Physics) OR Mathematics Practical based on Minor	**2**
On Job Training (OJT)		**4**
Total		**22**

Program Outcomes (PO):

A learner completing T.Y.B.Sc. will be able to:

PO1	Demonstrate analytical skills in applying appropriate science principles and methodologies to solve a wide range of problems.
PO2	Design and carry out experiments and analyze results by accounting uncertainties different quantities measured using various scientific instruments.
PO3	Demonstrate professional behavior of being unbiased and truthful in all aspects of Work as an individual as well as a team.
PO4	Develop critical thinking and analytical skills to assess complex chemical problems, design experiments, and interpret data.
PO5	Utilize modern laboratory techniques, including instrumental analysis and classical methods to conduct experiments and analyze results accurately.
PO6	Engage in self-directed learning and continue to update knowledge and skills in chemistry and related interdisciplinary areas to adapt to evolving scientific challenges.

Program Specific Outcomes (PSO's)

On completion of B.Sc. Chemistry program, learners will be enriched with knowledge and be able to

PSO1	Gain in-depth knowledge of physical chemistry concepts, including thermodynamics, kinetics and surface chemistry, as well as analytical techniques used in classical and modern chemical analysis.
PSO2	Understand nuclear reactions, radioactive decay, and the applications of radioisotopes in chemical analysis and dating methods, with practical insights into detection and measurement techniques.
PSO3	Demonstrate a comprehensive understanding of polymer science, including polymer classification, molar mass determination, and applications of light-emitting polymers in technological advancements.
PSO4	Develop proficiency in electroanalytical techniques such as polarography and amperometry, and understand their applications in the quantitative and qualitative analysis of chemical substances.
PSO5	Apply knowledge of fluorescence and phosphorescence spectroscopy for chemical analysis and compare these methods with absorption spectroscopy for various applications in industry and research.

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

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
UMMCHS5- 301	Paper I	02	2
	Unit I : PHYSICAL CHEMISTRY 1. CHEMICAL THERMODYNAMICS 2. CHEMICAL KINETICS 3. SURFACE CHEMISTRY	15 Lectures	
	Unit II: ANALYTICAL CHEMISTRY 1. Classical methods of analysis 2. Optical Methods-I 3. SeparationTechnique	15 Lectures	
		30 Lectures	

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

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
UMMCHS6- 301	**Paper I**	**02**	**2**
	Unit I : PHYSICAL CHEMISTRY **1. Nuclear Chemistry** **2. Polymers**	**15 Lectures**	
	Unit II: ANALYTICAL CHEMISTRY **1.Electroanalytical techniques** **2.Optical Methods-II**	**15 Lectures**	
		30 Lectures	

Detailed Syllabus: Unit wise / Module wise with number of lectures Course title: Physical and Analytical Chemistry

Objective: To understand and develop competence in use of physical and analytical Chemistry.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Acquainted with concepts of colligative properties such as elevation of boiling point, depression in freezing point & osmotic pressure.
LO2	Learn to Identify various methods to determine the colligative properties
LO3	Apply the knowledge of colligative properties.and will be able to solve the numericals
LO4	Acquainted with the collision theory of reaction rates and apply it to unimolecular reactions using the Lindemann mechanism.
LO5	Identify different types of reactions.
LO6	Identify various methods to determine the rate of reaction.
LO7	Acquainted with the physical and chemical adsorption by understanding and applying adsorption isotherm models.
LO8	Explain the electrical properties of colloids, including the origin of charges on colloidal particles. and describe electrokinetic phenomena such as electrophoresis and electro-osmosis.
LO9	Construct and interpret titration curves for neutralization titrations involving strong acids and weak bases or weak acids and strong bases based on pH changes.
LO10	Describe the principles of redox titrations and interpret titration curves based on EMF for one. electron systems.
LO11	Explain the principles of turbidimetry and nephelometry and the factors that affect radiation scattering.
LO12	Demonstrate understanding of solvent extraction, the Nernst distribution law, and factors influencing extraction efficiency.
LO13	Learn the concepts of ion exchange chromatography, the principles of ion exchangers, and the factors affecting ion separation, with specific applications to the separation of magnesium and zinc.

Course title: Physical and Analytical Chemistry SEM V

Course code: UMMCHS5-301

Unit no.	Details of topics	No of lectures
1	1. CHEMICAL THERMODYNAMICS 1) Colligative properties: Vapour pressure and relative lowering of vapour pressure. Measurement of lowering of vapour pressure - 2) Elevation in boiling point of a solution, thermodynamic derivation relating elevation in boiling point of the solution and molar mass of non-volatile solute. (simple numerical, No derivation only final expression) 3) Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and the molar mass of the non-volatile solute. Beckmann Method and Rast Method. (simple numerical, No derivation only final expression) 4) Osmotic Pressure: Introduction, Van't Hoff equation, Measurement of Osmotic Pressure - Berkeley and Hartley's Method, Reverse Osmosis. Van't Hoff Factor. (simple numerical, No derivation only final expression)	7 Lectures
	2. CHEMICAL KINETICS 1)Collision theory of reaction rates: Application of collision theory to Unimolecular reaction Lindemann theory (derivation expected) 2)Classification of reactions as slow, fast and ultra -fast. Study of kinetics of fast reactions by Stop flow method and Flash photolysis (No derivation expected).	4
	3. SURFACE CHEMISTRY 1) Adsorption: Physical and Chemical Adsorption, Langmuir's adsorption isotherm (Postulates only). B.E.T. equation for multilayer adsorption, (derivation not expected). Determination of surface area of an adsorbent using B.E.T. equation.(No numerical) 2) COLLOIDAL STATE Introduction to colloids - Emulsions, Gels and Sols. Electrical Properties: Origin of charges on colloidal particles, Concept of electrical double layer, zeta potential, Helmholtz and Stern model. Electro-kinetic phenomena - Electrophoresis, Electro-osmosis, Streaming potential, Sedimentation potential; Donnan Membrane Equilibrium	4

UNIT 2	**2.1 _Classical methods of analysis (6L)** 2.1.1 Neutralization titrations-Concept ofpH and its importance in neutrlization titrations 2.1.2-Construction of titration curve(on the basis of change in pH) of a titrtaion of storng acid against weak base/Weak acid against strong base 2.1.3-Redox titrations-introduction ,construction of titration curve (on the basis of EMF) in aqueous medium for one electron system. 2.1.4-Criteria for selection of an indicator	15L
	2.2 _Optical Methods- I Turbidimetry and Nephelometry (4L) 2.2.1-Introduction and principle 2.2.2-Factors affecting scattering of radiations: Concentration,Particle size ,Wavelength,refractive Index 2.2.3 Instrumentation and Applications	
	2.3 _Separation Technique (5L) **2.3.1 Solvent extraction-**Introduction, Nernst distribution law**,** Distribution ratio,Partition coefficient ,Factors affecting extraction,single step and multi step extraction, Batch and Continuous extraction 2.3.2-**Ion Exchange Chromatography** -Introduction, Principle. Types of Ion Exchangers , Ideal properties of resin,Factors affecting separation of ions,Application with reference to separation and determination of Magnesium and Zinc	

CHEMISTRY PRACTICALS **Semester 05**
Credits-2

UNIT-1	**Details of topics**	**No of lectures**
	1 **Colligative properties** To determine the molecular weight of compound by Rast Method **2.Chemical Kinetics** To determine the order between K2S2O8 and KI by fractional change method. **3.Surface phenomena** To investigate the adsorption of acetic acid on activated charcoal and test the validity of Freundlich adsorption isotherm. 4. **Spectrometry** :.To determine amount of of fluoride present in the given sample spectrophotometrically 5. **Turbidimetry** : To determine the amount of sulfate in the given water sample turbidimetrically 6. **Complexometric titration** :To estimate magnesium content in talcum powder by complexometry,using the standard solution of EDTA.	**30 hrs**

Detailed Syllabus: Unit wise / Module wise with number of lectures Course title: Physical and Analytical Chemistry

Course code: UMMCHS6-301

Objective: To understand fundamental concepts and develop skills in basic mechanics and thermodynamics.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Students will be acquainted with different types of radioactive decay (alpha, beta, gamma) and the concept of half-life and unit of radioactivity.
LO 2	Students will learn to Identify various methods and instruments used to detect and measure radiation (e.g., Geiger counters, scintillation counters) and understand their applications.
LO3	Students will learn to apply the knowledge of nuclear reaction and will be able to solve the numericals.
LO4	Student will be able to analyze fissile and fertile materials
LO6	Students will understand the principles of nuclear fusion and thermonuclear reactions occurring on stellar bodies and on Earth.
LO7	Students will learn to apply the knowledge to calculate molar masses of polymers by viscosity method (Ostwald Viscometer).
LO8	Students will be able to classify polymers based on source, structure, thermal response, and physical properties.
LO9	Differentiate between potentiometry and voltammetry, and explain the use of polarizable and non-polarizable electrodes.
LO10	Analyze the advantages and limitations of polarography and its applications in chemical analysis.

Course title: Physical and Analytical Chemistry SEM VI

Unit no.	Details of topics	No of lectures
1	NUCLEAR CHEMISTRY 1) Introduction: Basic terms-radioactive constants (decay constant, half-life and average life) 2) Detection and Measurement of Radioactivity: Types and characteristics of nuclear radiations, behaviour of ion pairs in electric field, detection and measurement of nuclear radiations using G. M. Counter and Scintillation Counter. 3) Application of use of radioisotopes as Tracers: chemical reaction mechanism, age determination - dating by C^{14} . 4) Nuclear reactions: nuclear transmutation (one example for each projectile), artificial radioactivity, Q - value of nuclear reaction, threshold energy. 5) Fission Process: Fissile and fertile material, nuclear fission, chain reaction, factor controlling fission process. multiplication factor and critical size or mass of fissionable material, nuclear power reactor and breeder reactor. 6) Fusion Process. Thermonuclear reactions occurring on stellar bodies and earth	**11**
1	POLYMERS 1) Basic terms: macromolecule, monomer, repeat unit, degree of polymerization. 2) Classification of polymers: Classification based on source, structure, thermal response and physical properties. 3) Molar masses of polymers: Number average, Weight average, Viscosity average molar mass, Monodispersity and Polydispersity 4) Method of determining molar masses of polymers : Viscosity method using Ostwald Viscometer. (No derivation expected) Light Emitting Polymers : Introduction, Characteristics, Method of preparation and applications	4

UNIT 2	**ANALYTICAL CHEMISTRY_ Electroanalytical techniques** 2.1 Polarography & Amperometry (10L) 2.1.1 Difference between potentiometry and voltammetry, Polarizable and non-polarizable electrodes 2.1.2 Basic principle of polarography:H-shaped polarographic cell,DME(construction,working, advantages and limitations) 2.1.3 DC Polarogram: Terms involved - Residual current, Diffusion current, Limiting current, Half-Wave Potential,Role and selction of supporting electrolyte,Interference of oxygen and removal,Polarographic maxima and maxima supressor 2.1.4 Quantitative aspects of polarography: Ilkovic equations: various terms involved in it (No derivation) 2.1.5 Qualitative aspects of Polarography: Half wave potential E1/2, Factors affecting E1/2 2.1.6 Applications advantages and limitations 2.1.7.Amperometric Titrations :Principle,Rotating Platinum Electrode-Construction, 2.1.8 Titration curves with example 2.1.9 Advantages and limitations	**15 Lectur es**
	2.2 Optical Methods-II :Molecular Fluorescence and Phosphorescence Spectroscopy (05 L) **2.2.1** Introduction and Principle 2.2.2 Relationship of Fluorescence intensity with concentration 2.2.3 Factors affecting Fluorescence and Phosphorescence 2.2.4 Instrumentation and applications 2.2.5 Comparison of Fluorimetry and Phosphorimetry 2.2.6 Comparison with Absorption methods	

CHEMISTRY PRACTICALS **Semester 06**

Credits-2

Unit no.	Details of topics	No of lectures
1	1. **Chemical Kinetics** To interpret the order of reaction graphically from the given experimental data and calculate the specific rate constant. (No fractional order) 2. **Viscosity** To determine the molecular weight of high polymer polyvinyl alcohol (PVA) by viscosity measurement.	**30 hrs**
	3.**Potentiometry** To determine the amount of iodide, bromide and chloride in the mixture by potentiometric titration with silver nitrate. **4..pH-metry** To determine acidic and basic dissociation constants of amino acid and hence to calculate isoelectric point. 5.**Conductometry** To titrate a mixture of weak acid and strong acid against strong base and estimate the amount of each acid in the mixture conductometrically. 6. **Ion Exchange Analysis**: Estimation of Mg+2 and Zn+2 using an anion exchange resin	

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3. Physical Chemistry, R.J. Silbey, & R.A. Alberty, 3rd edition , John Wiley & Sons, Inc [part 1]
4. Physical Chemistry, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House.
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6. Fundamental of Molecular Spectroscopy, 4 th Edn., Colin N Banwell and Elaine M McCash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.
7. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
8. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition, Oxford Universtity Press Oxford.
9. Physical Chemistry, G.K. Vemullapallie, 1997, Prentice Hall of India, Pvt.Ltd. New Delhi.
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12. Polymer Science, V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd., Publishers, 2005.
13. Essentials of Nuclear Chemistry, Arnikar, Hari Jeevan , New Age International (P) Ltd., Publishers, 2011..
14. Chemical Kinetics,K. Laidler, Pearson Education India, 1987.
15.Analytical Chemistry, Gary.D Christan, 5th edition
16.Analytical Chemistry Skoog, West ,Holler,7th Edition:
17.Analytical Chromatography, Gurdeep R Chatwal, Himalaya publication
18.Basic Concepts of Analytical Chemistry, by S M Khopkar, new Age International (p) Limited
19.Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
20.Fundamentals of Analytical Chemistry by Skoog and West , 8th Edition

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1.Vogel’s Textbook of Quantitative Chemical Analysis, 5thEdn., G. H. Jeffery, J Bassett, J Memdham and R C Denney, ELBS with Longmann (1989).

2.Vogel's Textbook of Quantitative Chemical analysis, Sixth edition, J.Mendham et.al

Course Title: Chemistry Paper 2 (Inorganic Chemistry I)

Course Code: UMMCHS5-302

Program Outcomes (PO):

A leaner completing B.Sc. Chemistry will be able to:

PO1	Showcase your inorganic skills by applying relevant scientific principles and methodologies to effectively address a variety of problems
PO2	Perform experiments and evaluate the outcomes by determining the uncertainties associated with different measurements.
PO3	Carry out experiments and analyze the data by calculating uncertainties in a range of measurements.

Program Specific Outcomes (PSO's)

On completion of B.Sc. Chemistry program, learners will be enriched with knowledge and be able to

PSO1	Enhance both theoretical and practical expertise in the field of inorganic chemistry.
PSO2	To explore the bonding models, structures, and applications of coordination complexes.
PSO3	Predicting the geometries of complexes using Molecular Orbital Theory (MOT) and Valence Bond Theory (VBT).
PSO4	Utilize group theory to identify and assign symmetry properties to molecules.

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

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
UMMCHS5-302	**Paper 02 Inorganic Chemistry**	**02**	**4**
	Unit I : 1.1 Molecular Symmetry 1.2 Chemical Bonding 1.3 Some Selected Topics	**15 Lectures**	
	Unit II: 2.1 Solid State Chemistry 2.2 Chemistry Of Inner Transition Elements	**15 Lectures**	

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
UMMCHS6-302	**T.Y.B.Sc. (CHEMISTRY) (SEMESTER VI)** **Paper 02 Inorganic Chemistry**	**02**	**4**
	Unit I : 1.1 Theories of the metal-ligand bond (I) 1.2 Theories of the metal-ligand bond (II)	**15 Lectures**	
	Unit II 2.1 Organometallic Chemistry 2.2 Some Selected Topics	**15 Lectures**	

Detailed Syllabus: Unit wise / ~~Module wise~~ with number of lectures Course title: Chemistry Paper 02 Inorganic Chemistry

Course code: UMMCHS6-302

Objective: To understand and develop competence in use of Basic of inorganic chemistry

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Students will be able to predict symmetry of molecules
LO2	Learner's will able to construct MO diagram of heteronuclear molecule
LO3	Learner's will able to understand chemistry of non-aqueous solvents
LO4	Learners will gain an understanding of the properties of oxyacids and interhalogen compounds.
LO5	Learner will gain knowledge of crystals
LO6	Learner will be able to explain properties of Lanthanides

Course title: Chemistry Paper 2 **Course code: UMMCHS6-302**

Unit no.	Details of topics	No of lectures
1	**Unit I :** **1.1 Molecular Symmetry (2L)** Introduction and Importance of Symmetry in Chemistry. Symmetry elements definitions and Symmetry operations. Concept of a Point Group with illustrations using the following point groups :(i) C2v (ii) C3v (iii)C2h and (iv)D3h **1.2 Chemical Bonding (6L)** Molecular Orbital Theory for heteronuclear diatomic molecules like HCl, NO Molecular orbital theory for H3 and $H3^{+}$. Molecular shape to molecular orbital approach in AB**2** molecules. Application of symmetry concepts for linear and angular species considering σ- bonding only. Examples : i) H2O ii) BeH2 **1.3 Some Selected Topics (7L)** Chemistry of Non-aqueous Solvents (2L) Trouton Constants, dielectric constant, Leveling Effect Reactions of Ammonia and N2O4 as a nonaqueous solvents Comparative Chemistry of Group 16 (2L) Electronic configurations, Allotropy of group 16, Manufacture of sulphuric acid by Contact process. Comparative Chemistry of Group 17 (3L) Electronic configuration , General characteristics, anamolous properties of fluorine, comparative study of acidity of oxyacids of chlorine w.r.t acidity, oxidizing properties and structures(on the basis of VSEPR theory) Interhalogens with reference to preparations, properties and structures on the basis of VSEPR theory	15 Lectures

2	**2.1 Solid State Chemistry (08L)** Explanation of terms viz. crystal lattice, lattice point, unit cell and lattice constants. Closest packing of rigid spheres (hcp,ccp), packing density in simple cubic, bcc and fcc lattices. Relationship between density, radius of unit cell and lattice parameters. Stoichiometric Point defects in solids (discussion on Frenkel and Schottky defects expected). Superconductivity, Explanation of terms like superconductivity, transition temperature, Meissner effect. Different types of superconductors viz. conventional superconductors, alkali metal fullerides, high temperature super conductors. Brief application of superconductors **2.2 Chemistry Of Inner Transition Elements (07L)** Position in periodic table and electronic configuration of lanthanides and actinides. Chemistry of Lanthanides with reference to (i) lanthanide contraction and its consequences(ii) Oxidation states (iii) Ability to form complexes (iv) Magnetic and spectral properties. Occurrence, extraction and separation of lanthanides by Ion Exchange method ,Applications of lanthanides.	15 Lectures

CHEMISTRY PRACTICALS **Semester 05**

	Details of topics
A	**Inorganic Chemistry**. 1. Preparation of Potassium diaquobis- (oxalato)cuprate (II) 2. Preparation of Ferrous ethylene diammonium sulphate. 3. Preparation of bisacetylacetonatocopper(II)
B	Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests). (Any three salts of transition metal ions) *(Standardisation of EDTA solution is not expected.)*

LO 01 Learner will gain theoretical aspects of Complex formation with specific geometry

LO 02 Learner will gain theoretical knowledge of MO formation in octahedral geometry and inorganic reaction attributes of Complexes.

LO 03 Learner will have exposure to competitive exams based on organometallic chemistry

LO 04 Learner will know the Inorganic pharmaceuticals and pigment Chemistry

LO 05 Students will learn about uses of different inorganic polymers

Course title: Chemistry Paper 02

Unit no.	**Details of topics**	**No of lectures**
1	**1.1 Theories of the metal-ligand bond (I) (08L)** Crystal Field Theory and effect of crystal field on central metal valence orbitals in various geometries from linear to octahedral (from coordination number 2 to coordination number 6) Splitting of d orbitals in octahedral, square planar and tetrahedral crystal fields. Distortions from the octahedral geometry:(i) effect of ligand field and (ii) Jahn-Teller distortions. Crystal field splitting parameters Δ; its calculation and factors affecting it in octahedral complexes, Spectrochemical series Crystal field stabilization energy(CFSE), calculation of CFSE for octahedral complexes with d^0 to d^{10} metal ion configurations. Consequences of crystal field splitting on various properties such as ionic radii, hydration energy and enthalpies of formation of metal complexes of the first transition series. Limitations of CFT Evidence for covalence in metal complexes (i) intensities of d-d transitions, (ii) ESR spectrum of $[IrCl6]^{2-}$ (iii) Nephelauxetic effect. **1.2 Theories of the metal-ligand bond (II) (07L)** Molecular orbital Theory for coordination compounds. Molecular orbitals of Construction of molecular orbitals for an ML6 complex. M.O. diagram for complexes Examples like $[FeF6]^{-4}$, $[Fe(CN)6]^{-4}$, $[FeF6]^{-3}$,$[Fe(CN)6]^{-3}$,$[CoF6]^{-3}$,$[Co(NH3)6]^{+3}$ Stability of Metal-Complexes Thermodynamic and kinetic perspectives of metal complexes with examples. Stability constants: stepwise and overall stability constants and their interrelationship. Factors affecting thermodynamic stability. Ligand substitution reactions: Associative and Dissociative mechanisms. Acid hydrolysis, base hydrolysis and anation reactions. Term symbols for transition metal ions, rules for determination of ground state term.	15 Lectures

2	**2.1 Organometallic Chemistry** Organometallic Compounds of main group metal General characteristics of various types of organometallic compounds, viz. ionic, bonded and electron deficient compounds. General synthetic methods of organometallic compounds : (i) Oxidative-addition, (ii)Metal-metal exchange(transmetallation), (iii) Carbanion-halide exchange, (iv) Metal-hydrogen exchange (metalation) and (v) Methylene insertion reactions. Metallocenes: Introduction, Ferrocene : Synthesis, properties, structure and bonding on the basis of VBT. Mechanism of Wilkinson's catalyst in hydrogenation of alkenes **2.2 Some Selected Topics** Introduction to Inorganic Pharmaceuticals with reference to Gastrointestinal agents, Topical Agents milk of magnesia, Al(OH)3,NaHCO3, Na3PO4,Calamine, KMnO4, Tincture iodine Inorganic Pigments Dyes Structure , Names, Formulae, Properties Uses, fluorescent pigments and Safety	15 Lectures

CHEMISTRY PRACTICALS SEMESTER VI

	Details of topics
A	**Inorganic Chemistry**. Inorganic preparations 1. Preparation of Tris(acetylacetonato) iron(III) 2. Green synthesis of bis(dimethylglyoximato) nickel(II) complex using nickel carbonate and sodium salt of dmg . 3. Preparation of potassium trioxalato aluminate (III)
B	Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests). (Any three salts of transition metal ions) *(Standardisation of EDTA solution is not expected.)*

References:

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1] Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry 2] J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, 3] Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition. 4] D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999) 5] Per Jensen and Philip R. Bunker , Fundamentals of Molecular Symmetry , Series in Chemical Physics, Taylor & Francis Group 6] J. S. Ogden, Introduction to Molecular Symmetry, Oxford University Press 7] Satya Prakash, G.D.Tuli, R.D. Madan. Advanced Inorganic Chemistry.S. Chand & Co Ltd 8]. C. N. R. Rao Advances in Solid State Chemistry 9] R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India. 10] Greenwood, N.N. and Earnshaw, Chemistry of the Elements, Butterworth Heinemann.1997.
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T.Y.B.Sc. (CHEMISTRY) (SEMESTER V)

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
UMMCH S5-303	**Paper: ORGANIC CHEMISTRY**	**02**	**2**
	Unit I : • Mechanism of organic Reactions and Photochemistry • Stereochemistry-I, Agrochemicals and Heterocyclic chemistry	**15 Lectures**	
	Unit II: • IUPAC nomenclature & synthesis of organic compounds • Spectroscopy-I and Natural Products	**15 Lectures**	

T.Y.B.Sc.

(CHEMISTRY)

(SEMESTER VI)

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
UMMCH S6-303	**Paper: ORGANIC CHEMISTRY**	**02**	**2**
	Unit I : • Stereochemistry II, Amino acids & Proteins • Molecular Rearrangement & Carbohydrates	**15 Lectures**	
	Unit II: • Spectroscopy & Nucleic acid • Catalysts and Reagents	**15 Lectures**	

SEMESTER-V

Detailed Syllabus: Unit wise / Module wise with number of lectures

Course title: ORGANIC CHEMISTRY Course code: UMMCH S5-303

Objective: To understand the basic concepts of organic reaction mechanism, stereochemistry, IUPAC nomenclature, heterocyclic chemistry and natural products.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	The evidence, mechanism & stereochemical aspects of substitution and elimination reactions.
LO2	To study the concept of pericyclic reactions
LO3	To know the difference between thermal and photochemical reactions.
LO4	To specify the spatial information necessary to identify chirality in a molecule without a stereogenic centre.
LO5	How to characterize products by physical and spectroscopic means including IR, NMR and MS
LO6	Basic stereochemistry
LO7	Spectroscopic techniques for structure elucidation of compounds using UV.IR, NMR and Mass spectroscopic techniques.
LO8	To learn the concept, synthesis and applications of agrochemicals
LO9	To rationalize the reactivity of heterocyclic compounds
LO10	To figure out the significance of natural products in terms of their biosynthesis, biological activity and chemical synthesis and combining organic and biological chemistry.

Course title: ORGANIC CHEMISTRY **Course code: UMMCH S5-303**

Unit No.	Details of topics	No of lectures
1	**Mechanism of organic reactions : (04 L)** ● The basic terms & concepts: ● Neighboring group participation in nucleophilic substitution reactions**:** participation of lone pair of electrons, kinetics and stereochemical outcome. ● Electro cyclic reactions (ring opening and ring closing), cycloaddition, sigma tropic Rearrangement, group transfer reactions, cheletropic reaction (definition and one example) ● Pyrolytic elimination- Cope, Chugaev, pyrolysis of acetates (with mechanism) **Photochemistry : (02 L)** ● Introduction: Difference between thermal and photochemical reactions. Jablonski diagram.	15 Lectures
	Stereochemistry I (3 L) ● Molecular chirality and elements of symmetry: Mirror plane symmetry, inversion center, rotation -reflection (alternating) axis. ● Stereochemistry of cumulenes, biphenyls and allenes. **Agrochemicals (3 L)** ● General introduction & scope, meaning & examples of insecticides, herbicides, fungicide, rodenticide, pesticides, ● Advantages & disadvantages of agrochemicals. ● Synthesis & application of IAA (Indole Acetic Acid) & Endosulfan. ● Bio pesticides – Neem oil & Karanj oil. **Heterocyclic chemistry: (3 L)** ● Quinoline and iso-quionoline. ● Quinoline (Skraup synthesis) and iso-quinoline (Bischler-Napieralski synthesis). ● Reactions of quinoline and isoquinoline; oxidation, reduction, nitration, halogenation and reaction with $NaNH_2$/liq.NH_3 (Chichibabin reaction), n-BuLi.	

2	**IUPAC (3 L)** ● IUPAC Systematic nomenclature of the following classes of compounds (including compounds upto two substituents / functional groups) ● Bicyclic compounds – spiro, fused and bridged (upto 11 carbon atoms) – saturated and unsaturated compounds. ● Biphenyls ● Allenes, Cummulenes with upto 3 double bonds **Synthesis of organic compounds (4 L)** ● Introduction: Linear and convergent synthesis, criteria for an ideal synthesis, concept of chemoselectivity and regioselectivity with examples. ● **Green chemistry and synthesis** ● Introduction: Twelve principles of green chemistry, concept of atom economy and E-factor, Green reagents: dimethyl carbonate. Green starting materials : D-glucose Green solvents : supercritical CO2 Green catalysts: Bio catalysts. **Spectroscopy I (04 L)** ● Introduction: Electromagnetic spectrum, units of wavelength and frequency ● UV – Visible spectroscopy: Basic theory, solvents, nature of UV-Visible spectrum, concept of chromophore, auxochrome, bathochromic and hypsochromic shifts, hyperchromic and hypochromic effects, chromophore-chromophore and chromophore-auxochrome interactions. ● Mass spectrometry: Basic theory. Nature of mass spectrum. General rules of fragmentation. Importance of molecular ion	15 Lectures

	peak, isotopic peaks, base peak, nitrogen rule, Fragmentation of alkanes and aliphatic carbonyl compounds. **Natural Products: (4 L)** ● Terpenoids: Introduction, Isoprene rule, special isoprene rule. ● **Citral:** ○ Synthesis of citral from methyl heptenone ● **Alkaloids** Introduction, occurrence. Importance of alkaloids ● **Nicotine:** ○ Synthesis of nicotine from nicotinic acid ○ Harmful effects of nicotine	

SEMESTER-V

Detailed Syllabus: Unit wise / Module wise with number of lectures

Course title: ORGANIC CHEMISTRY PRACTICAL

Objective: To understand the basic concepts and importance of reagents in binary separation of organic mixture.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	How to engage in safe laboratory practices by handling laboratory glassware, equipment, and chemical reagents appropriately
LO2	To develop skills of observation, recording and analyzing data.
LO3	To study the solubility and precipitation criteria of various organic

CHEMISTRY PRACTICALS Semester 05

Unit no.	Details of topics	No of lectures
	Separation of Binary solid-solid mixture (Any Six) **(2.0 gms mixture to be given).** 1. Minimum Six mixtures to be completed by the students. 2. Components of the mixture should include water soluble and water insoluble acids (carboxylic acid), water insoluble phenols(2-naphthol, 1-naphthol), water insoluble bases (nitroanilines) , water soluble neutral (thiourea) and water insoluble neutral compounds (anilides , amides, m-DNB, hydrocarbons) 3. After correct determination of chemical type, the separating reagent should be decided by the student for separation. 4. Follow separation scheme with the bulk sample of binary mixture. 5. After separation into component A and component B, one component (decided by the examiner) is to be analyzed and identified with mp.	

References (SEMESTER V)

REFERENCES THEORY

Unit I

1. A guidebook to mechanism in Organic Chemistry, 6**th** edition, Peter Sykes, Pearson education, New Delhi
2. Organic Reaction Mechanism, 4th edition, V. K. Ahluwalia, R. K. Parashar, Narosa Publication.
3. Organic reactions & their mechanisms,3rd revised edition, P.S. Kalsi, New Age International Publishers.
4. M.B.Smith and J. March, Advanced organic chemistry- reactions mechanism and structure, 5th edition.
5. Organic Chemistry, 7th Edition, R.T. Morrison, R. N. Boyd & S. K. Bhattacharjee, Pearson.
6. Organic chemistry,8th edition, John Mc Murry
7. Heterocyclic chemistry, 3rd Edition, Thomas L. Gilchrist, Pearson Education, 2007.
8. Eliel , stereochemistry of carbon compounds, Tata McGraw Hill
9. Stereochemistry P.S.Kalsi , New Age International Ltd.,4th Edition
10. Stereochemistry by Nassipuri.
11. Insecticides & pesticides: Saxena A. B., Anmol publication.
12. Growth regulators in Agriculture & Horticulture: Amarjit Basra, CRC press 2000.
13. Agrochemicals and pesticides: A.Jadhav and T.V.Sathe.
14. Name Reactions in Heterocyclic Chemistry, Jie-Jack Li, Wiley-Interscience publications, 2005.
15. Handbook of Heterocyclic Chemistry, 2nd Edition, Alan R. Katritzky and Alexander F. Pozharskii, Elsevier Science Ltd, 2000.
16. Heterocyclic Chemistry, 5th Edition, John A. Joule and Keith Mills, Wiley publication, 2010.

Unit II

1. Nomenclature of Organic Chemistry**:** IUPAC recommendations and preferred Names 2013, RSC publication.
2. IUPAC nomenclature by S.C.Pal.
3. Green chemistry an introductory text: Mike Lancaster.
4. Green chemistry: V. K. Ahluwalia (Narosa publishing house Pvt. Ltd.)
5. Green chemistry an introductory text: RSC publishing.
6. New trends in green chemistry V. K. Ahluwalia , M. Kidwai, Klumer Academic publisher
7. Green chemistry by V. Kumar.
8. Organic chemistry: Francis Carey
9. Organic chemistry: Carey and Sundberg.
10. Organic spectroscopy (Second edition),Jag Mohan ,Narosa publication
11. Spectroscopy, Pavia, Lampman, Kriz,Vyvyan.
12. Elementary organic spectroscopy (Third edition), Y.R.Sharma, S. Chand publication..
13. Introduction to spectroscopy (third edition), Pavia, Lampman, Kriz,john vondeling, Emily Barrosse.

14. Organic chemistry Paula Y. Bruice, Pearson education.
15. Spectral identification of organic molecules by Silverstein.
16. Absorption spectroscopy of organic molecules by V. M. Parikh.
17. Chemistry of natural products by Chatwal Anand – Vol I and Vol II
18. Chemistry of natural products by O.P. Agarwal
19. Chemistry of natural products by Meenakshi Sivakumar and Sujata Bhat.
20. Organic chemistry by Morrision and Boyd, 7th edition.
21. I.L.Finar, Vol-I and Vol-II, 5th edition.

REFERENCES PRACTICAL

1. Practical organic chemistry – A. I. Vogel
2. Practical organic chemistry – H.Middleton.
3. Practical organic chemistry – O.P.Agarwal.

SEMESTER-VI

Detailed Syllabus: Unit wise / Module wise with number of lectures

Course title: ORGANIC CHEMISTRY Course code: UMMCH S6-303

Objective: To understand the basic concepts of Stereochemistry, Molecular Rearrangement, Biomolecules, Spectroscopy, Polymer and Reagents.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	To study the concept of selectivity and topicity.
LO2	To study the stereochemical aspects of various organic reactions
LO3	To learn the basic chemical and structural features of amino acids and proteins.
LO4	To predict and write the mechanism and stereochemistry of various molecular rearrangement reactions.
LO5	To represent the carbohydrates in various spatial arrangements and interconvert them
LO6	To write various reactions pertaining to different functional group transformations in carbohydrates
LO7	Brief idea about the advantages of spectroscopic methods.
LO8	Various terminology used and basic concept of IR and PMR.
LO9	Application of UV, Mass and PMR spectroscopy in structural determination

Course title: ORGANIC CHEMISTRY **Course code: UMMCH S6-303**

Unit no.	Details of topics	No of lectures
1	**Stereochemistry II (4 L)** ● Stereoselectivity and stereospecificity: Idea of enantioselectivity (ee) and diastereoselectivity (de), Topicity: enantiotopic and diasterotopic atoms, groups and faces. ● Stereochemistry of – Addition reactions to olefins: a) Bromination (electrophilic anti addition) b) Syn hydroxylation with OsO_4 and $KMnO_4$ **Amino acids & Proteins (3 L)** ● α-Amino acids: General Structure, configuration, and classification Based on structure and nutrition. Properties: pH dependency of ionic structure, isoelectric point and zwitterion. ● Polypeptides and Proteins: nature of peptide bond. Nomenclature and representation of polypeptides (di-and tri-peptides) ● Proteins: general idea of primary, secondary, tertiary & quaternary structure.	15 Lectures
	Molecular Rearrangements (3 L) Mechanism of the following rearrangements with examples and stereochemistry wherever applicable. ● Migration to the electron deficient carbon: Pinacol-pinacolone rearrangement. ● Migration to the electron deficient nitrogen: Beckmann rearrangement. ● Migration involving a carbanion: Favorskii rearrangement. **Carbohydrates (05 L)** ● Introduction: classification, reducing and non-reducing sugars, DL notation ● Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides) and Haworth formula (furanose and pyranose forms of pentoses and hexoses) Interconversion: open chain and Haworth forms of monosaccharides with 5 and 6 carbons. Chair conformation with stereochemistry of D-glucose. ● Stereoisomers of D-glucose: enantiomer, diastereomers, anomers, epimers. ● Reactions of D-glucose: (a) Osazone formation (b) reduction: Hi/Ni, $NaBH_4$ (c) oxidation: bromine water, HNO_3, HIO_4 (d) acetylation (e) methylation:(d) and (e) with cyclic pyranose forms	

2	**Spectroscopy II (9 L)** ● IR Spectroscopy: Basic theory, nature of IR spectrum, selection rule, fingerprint region. ● PMR Spectroscopy: Basic theory of PMR, nature of PMR spectrum, chemical shift (δ unit), standard for PMR, solvents used. Factors affecting chemical shift: (1) inductive effect (2) anisotropic effect (with reference to C=C, C≡C, C=O and benzene ring). Spin- spin coupling and coupling constant. Application of deuterium exchange technique. Application of PMR in structure determination. ● Rule 13 of mass spectroscopy. ● Spectral characteristics of following classes of organic compounds, including benzene and monosubstituted benzenes, with respect to IR and PMR: (1) alkanes (2) alkenes (3) alkynes (4) haloalkanes (5) alcohols (6) carbonyl compounds. Problems of structure elucidation of simple organic compounds using individual or combined use of UV-Vis, IR, Mass and NMR spectroscopic technique are expected. (Index of hydrogen deficiency should be the first step in solving the problems). **Nucleic Acids (2 L)** ● Controlled hydrolysis of nucleic acids. sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA. Structures of nucleic acids (DNA and RNA) including base pairing.	15 Lectures

	Catalysts and Reagents (4 L) ● Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism). ● Catalysts: Catalysts for hydrogenation: a. Raney Nickel b. Pt and PtO_2 (C=C, CN, NO_2, aromatic ring) c. Pd/C : C=C **Reagents:** ● SeO_2 (Oxidation of CH_2 alpha to CO) ● mCPBA (epoxidation of C=C)	

SEMESTER-VI

Detailed Syllabus: Unit wise / Module wise with number of lectures

Course title: ORGANIC CHEMISTRY PRACTICALS

Course code: UMMCH S6-303

Objective: To understand the basic concepts and importance of separation techniques in binary separation of organic mixture.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	How to engage in safe laboratory practices by handling laboratory glassware, equipment, and chemical reagents appropriately
LO2	To develop skills of observation, recording and analyzing data.
LO3	To study the solubility and separation criteria for organic compounds. To study the basic concepts of distillation techniques.

CHEMISTRY PRACTICALS Semester 06

Unit no.	Details of topics	No of lectures
	Separation of Binary liquid-liquid and liquid- solid mixture.(Any Six) 1. Minimum Six mixtures to be completed by the students. 2. Components of the liq-liq mixture should include volatile liquids like acetone, methylacetate, ethyl acetate, isopropyl alcohol, ethyl alcohol, EMK and non volatile liquids like chlorobenzene , bromobenzene, aniline, N,N dimethylaniline, acetophenone, nitrobenzene, ethyl benzoate. 3. Components of the liq- solid mixture should include volatile liquids like acetone, methylacetate, ethyl acetate, ethyl alcohol, IPA, EMK and solids such as water insoluble acids, phenols, bases, and neutral. 4. A sample of the mixture one ml to be given to the student for detection of the physical type of the mixture. 5. After correct determination of physical type, separation of the binary mixture to be carried out by distillation method using microscale technique. 6. After separation into component A and component B, the compound to be identified can be decided by the examiner.	

References (SEMESTER VI)

REFERENCES THEORY

Unit I

1. Refer Stereochemistry –I (Sem-V, Unit-II)
2. Biochemistry, 8th Ed., Jeremy Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto Pub. W. H. Freeman Publishers
3. Lehninger Principles of Biochemistry 7th Ed., David Nelson and Michael Cox, Publisher W. H. Freeman
4. Name Reactions – Jie Jack Li, 4th Edition, Springer Pub.
5. Refer Mechanism of organic reaction (Sem-V, Unit-I)
6. Organic chemistry (fourth edition),G,Marc Loudon,Oxford University press.
7. Introduction to Organic Chemistry (Third edition), Andrew Streitwieser, Jr. Clayton H. Heathcock, Macmilan publishing.
8. Organic chemistry fourth edition, Morrision and Boyd.
9. Introduction to Organic chemistry,John McMurry.
10. Organic chemistry volume-1&2 (fifth and sixth edition) IL Finar

Unit III

1. Refer spectroscopy –I, (Sem-V, Unit-IV)
2. Organic chemistry R.T.Morrison and R.N.Boyd, 6th edition, pearson education
3. S.H.Pine, organic chemistry 4th edition. McGraw Hill
4. Polymer chemistry by M.G.Arora, K.Singh.
5. Polymer science – a text book by Ahluwalia and Mishra
6. Introduction to polymer chemistry - R.Seymour, Wiley Interscience.
7. Organic chemistry by Francis Carey – McGrawHill .
8. Organic chemistry by Carey and Sundberg, Part A & B

REFERENCES PRACTICAL

1. Practical organic chemistry – A. I. Vogel
2. Practical organic chemistry – H.Middleton.
3. Practical organic chemistry – O.P.Aggarwal

Modality of Assessment

The performance of the learners for those exams having Semester End Examinations and Internal Assessment shall be evaluated in two parts as per the following ratio:

Semester End Examination: Internal Assessment [60:40]

The learner's performance shall be assessed by conducting the **Semester-end Examination with 60% marks** and **Continuous Internal Assessment (CIA) with 40% mark**s.

Students will have to score 40% of marks INDIVIDUALLY in Internal assessment as well as Semester-end Examination to pass the course.

Internal Assessment: It is defined as the assessment of the learners on the basis of internal evaluation by way of participation of learners in various academic and correlated activities in the given semester of the programme.

Semester End Assessment: It is defined as the assessment of the learners on the basis of Performance in the Semester-end Theory/ Practical examination.

Table-1- Mode of Assessment under NEP 2020

Name of the course	Nature of Evaluation & Mode of Assessment	Credits	Duration	Marks
Major (Organic Chemistry) Subject Course (Theory)	**1. Internal (40%)** (Table 2)	**2-Credit**	-	20
	2. Semester-end Examination 60%)		**75 min**	30
Major (Organic Chemistry) (Practical)	**Semester-end Practical Examination** (Table-3)	**2-Credit**	**3 hrs**	50

Table - 2

Theory - Mode of assessment-Continuous Internal Assessment [40%]

Evaluation type
Assignments. Project based learning activities (Group Discussion Research/ Case studies/ Reports / Assignments / Presentations / Skit / Poster / etc.). Class Test (Objective - Multiple Choice Questions/ Subjective). Active participation in class activities. Overall conduct as a responsible student with respect to good behaviour, leadership qualities, interpersonal skills etc.

A. Theory - Internal assessment 40% **20 marks**

Sr No	Evaluation type	Marks
1.	- Tests, Assignments, - Project based learning activities (Group Research/ Case studies/ Reports / Assignments / Presentations / Skit / Poster / etc.), - Class Test (multiple choice questions / objective)	10
2.	- Active participation in routine class activity - Overall conduct as a responsible student, with respect to good behaviour, leadership qualities, interpersonal skills etc.	10

B. Theory - External examination - 60% **30 marks**

Semester End Theory Assessment

Duration - Each paper shall be of 2.5 hours duration.

1. Theory question paper pattern :-

There shall be SIX questions.

Question No 01 will be based on Unit 01 (Any Three out of Six)

Question no.	Details	Marks
Q1.	**Unit 01**	
	Any Three out of Six	15M
	Attempt any three of the five	
Q2.	**Unit 02**	15M
	Attempt any three of the five	

C. Semester End Practical Assessment **50 marks**

		50 Marks
A	Any one experiment	40
B	Viva	05
C	Journal	05

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Coordinator / In-charge of the department ; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

SEMESTER V

Course	VESUSCH503	Grand Total
Theory	50	50
Practicals	50	50

SEMESTER VI

Course	VESUSCH603	Grand Total
Theory	50	50
Practicals	50	50

T Y B Sc Chemistry

Choice Based Credit System

SEMESTER V

ELECTIVE(Drugs and Dyes)

COURSE CODE: UMMCHS5-311 CREDITS: 02 LECTURES: 60

Unit			Topics	
I	**1.1**		**General Introduction to Drugs**	**(8L)**
		1.1.1	Definition of a drug, sources of drugs, requirements of an ideal drug, classification of drugs (based on therapeutic action),	
		1.1.2	Nomenclature of drugs: Generic name, Brand name, Systematic name	
		1.1.3	Definition of the following medicinal terms: Pharmacon, Pharmacology, Pharmacophore, Prodrug, Half – life efficiency, LD_{50}, ED_{50},GI_{50} Therapeutic Index.	
		1.1.4	Brief idea of the following terms: Receptors, Agonists, Antagonists, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia.	
	1.2		**Routes of Drug Administration and Dosage Forms**	**(3L)**
		1.2.1	Oral and Parenteral routes with advantages and disadvantages.	
		1.2.2	Formulations & combination formulation, Different dosage forms (including Patches & Adhesives, emphasis on sustained release formulations and enteric coated tablets).	
	1.3		**Pharmacodynamic agents:** A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical structure, chemical class, therapeutic uses, and side effects.	
		1.3.1	**CNS Drugs:** Classification based on pharmacological actions: CNS Depressants & CNS Stimulants. Concept of sedation and hypnosis, anaesthesia. ● Phenytoin (Hydantoin) ● Trimethadione (Oxazolidinediones) (**Synthesis from acetone)** ● Alprazolam (Benzodiazepines) ● Levetiracetam (Pyrrolidines) ● Amphetamine (Phenethylamine) (**Asymmetric synthesis from phenyl acetic acid)** ● Chlorpromazine (Phenothiazines)	**(4L)**

UNIT-II (Drugs)

2	**2.1**		**Analgesics, Antipyretics and Anti-inflammatory Drugs.**	**(4L)**
		2.1.1	**Analgesics and Antipyretics** ● Morphine (Phenanthrene alkaloids) ● Tramadol (Cyclohexanols) (**Synthesis from salicylic acid)** ● Aspirin (Salicylates) ● Paracetamol (p-Amino phenols)	
		2.1.2	**Anti-inflammatory Drugs** Mechanism of inflammation and various inflammatory conditions. ● Steroids: Prednisolone, Betamethasone ● Sodium Diclofenac, Aceclofenac (N- Aryl anthranilic acids) **(Synthesis from 2,6-dichlorodiphenyl amine)**	
	2.2		**Antihistaminic Drugs**	**(2L)**
			● Diphenhydramine (Ethanol amines) ● Cetrizene (Piperazine) (**Synthesis from 4-Chlorobenzhydryl chloride)** ● Chlorpheniramine maleate (Ethyl amines) ● Pantoprazole (Benzimidazoles)	
	2.3		**Cardiovascular drugs**	**(3L)**
			Classification based on pharmacological action ● Isosorbide dinitrate (Nitrates) ● Valsartan (Amino acids) (structure not expected) ● Atenolol (Aryloxy propanol amines) (**Synthesis from 3-Hydroxy phenyl acetamide)** ● Amlodipine (Pyridines) ● Frusemide /Furosemide (Sulfamoyl benzoic acid) ● Rosuvastatin (Pyrimidine)	
	2.4		**Antidiabetic Agents**	**(2L)**

			General idea and types of diabetes; Insulin therapy ● Glibenclamide (Sulphonyl ureas) ● Metformin (Biguanides) ● Dapagliflozin (Pyranose) ● Pioglitazone (Thiazolidinediones) (**Synthesis from 2-(5-ethylpyridin-2-yl) ethanol)**	
	2.5		**Antiparkinsonism Drugs**	**(2L)**
			Idea of Parkinson's disease. ● Procyclidine hydrochloride (Pyrrolidines) ● Ethopropazine hydrochloride (Phenothiiazines) ● Levodopa (Amino acids) (**Synthesis from Vanillin)**	
	2.6		**Drugs for Respiratory System** General idea of: Expectorants; Mucolytes; Bronchodilators; Decongestants; Antitussives ● Ambroxol (Cyclohexanol) (**Synthesis from paracetamol)** ● Salbutamol (Phenyl ethyl amines) ● Oxymetazoline (Imidazolines)	**(2L)**
			Codeine Phosphate (Opiates)	

Reference Books: (For units I & II)

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippmcolt Williams & Wilkins.
2. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.
3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
4. Burger's Medicinal Chemistry, Drug Discovery and Development. Abraham and Rotella. Wiley
5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
7. Principle of medicinal chemistry. Vol 1 &2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.
9. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitsher, Wliey.

Unit III (Dyes)

3	**3.1**		Introduction to the dye-stuff Industry	**(5L)**
		3.1.1	Dyes	
			Definition of dyes, requirements of a good dye i.e. Colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, Fastness, Substantivity, Economic viability. Definition of fastness and its properties and Mordants with examples Explanation of nomenclature or abbreviations of commercial dyes with at least one example suffixes – G, O, R, B, K, L, C, S H, 6B, GK, 6GK, Naming of dyes by colour index (two examples) used in dye industries.	
		3.1.2	Natural and Synthetic Dyes	
			Natural Dyes: Definition and limitations of natural dyes. Examples and uses of natural dyes w.r.t Heena, Turmeric, Saffron, Indigo, Madder, Chlorophyll –**names** of the chief dyeing material/s in each natural dye **[structures not expected]**, Synthetic dyes: Definition of synthetic dyes, primaries and intermediates. Important milestones in the development of synthetic dyes – Emphasis on Name of the Scientist, dyes and the year of the discovery is required. (structure is not expected)	
	3.2		Substrates for Dyes : Types of fibres	**(3L)**
		3.2.1	Natural: cellulosic and proteinaceous fibres, examples – wool, silk and cotton structures and names of dyes applied on each of them.	
		3.2.2	Semi – synthetic: definition and examples [structures not expected]	
		3.2.3	Synthetic: Nylon, Polyesters and Polyamides structures and names of dyes applied on each of them	
		3.2.4	Blended fabrics: definition and examples [structures not expected]	
		3.2.5	Binding forces of dyes on substrate: ionic forces, covalent linkages, hydrogen bonding, vander-walls forces	
	3.3		Classification of dyes based on applications and dyeing methods	**(7L)**
		3.3.1	Dyeing methods	
			Basic Operations involved in dyeing process: i. Preparation of fibres ii. Preparation of dyebath iii. Application of dyes iv. Finishing	
			Dyeing Method of Cotton Fibres: (i) Direct dyeing (ii) Vat dyeing (iii) Mordant dyeing (iv) Disperse dyeing	

		3.3.2	Classification of dyes based on applicability on substrates (examples with structures) (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes – Diazo components; Fast yellow G, Fast orange R. Coupling components. Naphthol AS, Naphthol ASG (e) Mordant Dyes-Eriochrome Black A, Alizarin. (f) Vat Dyes- Indanthrene brown RRD, (g) Sulphur Dyes- Sulphur Black T (no structure) (h) Disperse Dyes-Celliton Fast brown 3R, (i) Reactive Dyes- Cibacron Brilliant Red B,	
		3.3.3	Optical Brighteners: General idea, important characteristics of optical brighteners and their classes [Stilbene, Coumarin, Heterocyclic vinylene derivatives, Diaryl pyrazolines, Naphthylamide derivatives] general structure of each class.	

Unit – IV (Dyes)

4	**4.1**		**Colour and Chemical Constitution of Dyes**	**(4L)**
		4.1.1	Absorption of visible light, Colour of wavelength absorbed, Complementary colour.	
		4.1.2	Relation between colour and chemical constitution.	
			(i) Armstrong theory (quinonoid theory) and its limitations. (ii) Witt's Theory: Chromophore, Auxochrome, Bathochromic & Hypsochromic Shift, Hypochromic & Hyperchromic effect (iii) Valence Bond theory, comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenzene, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones. (iv) Molecular Orbital Theory.	
	4.2		**Unit process and Dye Intermediates**	
		4.2.1	**A brief idea of Unit Processes**	**(3L)**
			Introduction to primaries and intermediates	
			Unit processes: definition and brief ideas of below unit processes: (a) Nitration (b) Sulphonation (c) Halogenation (d) Diazotization: (3 different methods & its importance) (e) Ammonolysis (f) Oxidation NB: Definition, Reagents, Examples of each unit processes mentioned above with reaction conditions (mechanism is not expected)	

		4.2.2	**Preparation of the Following Intermediates**	**(8L)**
			Benzene derivatives: Benzenesulphonic acid; 1,3-Benzenedisulphonic acid; sulphanilic acid; o-, m-, p-chloronitrobenzenes; o-, m-, p-nitroanilines; o-, m-, p-phenylene diamines; Naphthol ASG	
			Naphthalene Derivative: Schaeffer acid; Tobias acid; Naphthionic acid; N.W. acid; cleve-6-acid; H-acid; Naphthol AS	
			Anthracene Derivative: 1-Nitroanthraquinone; 1-Aminoanthraquinone Anthraquinone-2-sulphonic acid; Benzanthrone.	

References (For Units III & IV):

1. Chemistry of Synthetic Dyes, Vol I – VIII, Venkatraman K., Academic Press 1972
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995
3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973

I] Practicals

SEMESTER V

(Drugs and Dyes)

COURSE CODE: **CREDITS: 02**

1. Estimation of Ibuprofen (back titration method)
2. Estimation of Acid neutralizing capacity of a drug
3. Preparation of Aspirin from salicylic acid.
4. Separation of components of natural pigments by paper chromatography (eg: chlorophyll)

II] Project:

Preparation of Orange II dye (semi-microscale1.0gms) and its use for dyeing different fabrics

SEMESTER VI

(Drugs and Dyes)

COURSE CODE:UMMCH S6-311

CREDITS: 02 **LECTURES: 60**

UNIT – I (Drugs)

1	**1.1**		**Drug Discovery, Design and Development**	**(6L)**
		1.1.1	Discovery of a Lead compound: Screening, drug metabolism studies and clinical observation, Lipinski's rule of 5	
		1.1.2	Medicinal properties of compounds from Natural Sources: Anti-infective and anticancer properties of Turmeric (Curcumin)	
		1.1.3	Development of drug: The Pharmacophore identification, modification of structure or functional group, Structure activity relationship (Sulphonamides).	
		1.1.4	Structure modification to increase potency: Homologation, Chain branching and Extension of the structure.	
		1.1.5	Computer assisted drug design.	
	1.2		**Drug Metabolism:** Introduction, Absorption, Distribution, Bio-transformation, Excretion Different types of chemical transformation of drugs with specific examples.	**(3L)**
	1.3		**Chemotherapeutic Agents:** Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, side effects and introduction to MDR wherever applicable.	
		1.3.1	**Antibiotics and antivirals:** Definition, • Amoxicillin (β- lactum antibiotics) • Cefpodoxime (Cephalosporins) • Doxycycline (Tetracyclines) • Levofloxacin (Quinolones) (**Synthesis from 2,3,4 – Trifluro -1-nitrobenzene)** • Aciclovir/Acyclovir (Purines)	**(2L)**
		5.3.2	**Antimalarials:** Types of malaria; Symptoms; Pathological detection during window period (Life cycle of the parasites not to be discussed) • Chloroquine (3-Amino quinolones) • Artemether(Benzodioxepins) **Following combination to be discussed:**Atremether-Lumefantrine (no structure)	**(2L)**

		1.3.3	**Anthelmintics and AntiFungal agents** Drugs effective in the treatment of Nematodes and Cestodes infestations.	**(2L)**

			• Diethyl carbamazine (Piperazines) • Albendazole (Benzimidazoles) (**Synthesis from 2- Nitroaniline)** • Clotrimazole (Imidazole) • Fluconazole (Triazole) (**Synthesis from 1- Bromo – 2,4-difluorobenzene)**	

UNIT – II(Drugs)
Chemotherapeutic Agents continued.

2	**2.1**		**Antiamoebic Drugs** Types of Amoebiasis ● Metronidazole, Ornidazole, Tinidazole (Imidazole) Synthesis of Metronidazole from glyoxal by Debus-Radziszewski imidazole synthesis route **Following combination therapy to be discussed:** Ciprofloxacin-Tinidazole	**(1L)**
	2.2		**Antitubercular and Antileprotic Drugs** Types of Tuberculosis; Symptoms and diagnosis of Tuberculosis. Types of Leprosy. General idea of Antibiotics used in their treatment. ● PAS (Amino salicylates) ● Isoniazide (Hydrazides) ● Pyrazinamide (Pyrazines) ● (+) Ethambutol (Aliphatic diamines) (**Synthesis from 1- Nitropropane)** ● Dapsone(Sulphonamides) (**Synthesis from 4- Chloronitrobenzene)** ● Clofazimine (Phenazines) ● Bedaquiline (Quinoline) **Following combination therapy to be discussed:** (i) Rifampin + Ethambutol + Pyrazinamide (ii) Rifampin + Isoniazide + Pyrazinamide	**(3L)**
	2.3		**Anti-Neoplastic Drugs** Idea of malignancy; Causes of cancer Brief idea of Immuno Stimulants &Immuno depressants ● Lomoustine (Nitrosoureas) ● Anastrozole(Triazoles) (**Synthesis from 3,5-bis (bromo methyl) toluene)** ● Cisplatin (Chloro Platinum) ● Vincristine, Vinblastine, Vindesine) (Vinca alkaloids) (structure not expected)	**(2L)**
	2.4		**Anti-HIV Drugs** Idea of HIV pathogenicity, Symptoms of AIDS ● AZT/Zidovudine, Lamivudine,DDI (Purines)	**(1L)**

	2.5		**Drug Intermediates:** Synthesis and uses 1. 2,3,6-Triamino-6- hydroxypyrimidine from Guanidine 2. p-[2'-(5-Chloro-2-methoxy benzamido) ethyl]-benzenesulphonamide from Methyl-5-chloro-2- methoxybenzene 3. 3-(p-Chlorophenyl)-3- hydroxypiperidine from 3-Chloroacetophenone	**(2L)**

			4. p-Acetyl amino benzenesulphonyl chloride from Aniline 5. Epichlorohydrine from propene	
	2.6		**Nano particles in Medicinal Chemistry** Introduction; Carbon nano particles (structures) and Carbon nano tubes: ● Functionalization for Pharmaceutical applications ● Targeted drug delivery ● In vaccine (Foot and mouth disease) ● Use in Bio-physical treatment. Gold nano particles in treatment of: Cancer; Parkinsonism; Alzheimer. Silver nano particles: Antimicrobial activity.	**(4L)**
	2.7		**Drugs and Environmental Aspects** ● Impact of Pharma-industry on environment, ● International regulation for human experimentation with reference to: "The Nuremberg Code" and "The Helsinki Declaration".	**(2L)**

Reference Books (For Units I & II):

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippmcolt Williams & Wilkins.
2. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.
3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
4. Burger's Medicinal Chemistry, Drug Discovery & Development. Abraham & Rotella. Wiley
5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
7. Principle of medicinal chemistry. Vol 1 & 2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.
9. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitsher, Wliey.
11. Text book of drug design and discovery. Povl-Krog-Sgaard-Larsen, Tommy Liljefors and ULF Madsen, 3rd Edition Taylor & Francis.
12. Bio-applications of nanoparticles. Edited by Warren C.W. Chan, Springer Publication.
13. Nanoparticle and technology for drug delivery (Drugs and pharmaceutical sciences). Ram B.Gupta& Uday B.Kompella Pub. Informa Healthcare.
14. Nano forms of carbon and its applications. Edited by Maheshwar Sharon and Madhuri Sharon.MonadNanotechPvt. Ltd.
15. Environmental Chemistry. A. K. De
16. Text Book on Law and Medicine. Chokhani and Ghormade. 2nd Edition. Hind Law House,Pune.
17. Essentials of Medical Pharmacology. K D Tripathi, Jaypee Brothers Medical publishers Pvt. ltd.

Practical organic chemistry, Vogel.

SEMESTER VI

Unit – III (Dyes)

3	**3.1**		**Classification of Dyes based on Chemical Constitution and Synthesis of Selected Dyes** (Synthesis of the dyes marked with * is expected)	**(12L)**
			i)Nitro Dye: Naphthol Yellow S	
			ii) Nitroso Dye: Gambine Y	
			iii) Azo dyes: a) Monoazo dyes: Orange IV *(from sulphanilic acid) & Eriochrome Black T* (from β- naphthol) b) Bisazo dyes: Congo Red* (from nitrobenzene) c) Trisazo Dye: Direct Deep Black EW* (from benzidine)	
			iv)Diphenylmethane dye: Auramine O* (from N,N-dimethyl aniline)	
			v) Triphenylmethane dye: a) Diamine series: Malachite Green* (from benzaldehyde) b) Triamine series: Acid Magenta c) Phenol series: Rosolic acid	
			vi) Heterocyclic Dyes: a) Thiazine dyes: Methylene Blue b) Azine dyes: Safranin T* (from o-toluidine) c) Xanthene Dyes: Eosin* (from phthalic anhydride) d) Oxazine Dyes: Capri Blue e) Acridine Dyes: Acriflavine	
			vii) Quinone Dyes: a) Naphthaquinone: Naphthazarin b) Anthraquinone Dyes: Indanthrene Blue* (from anthraquinone)	
			viii) Indigoid Dyes: Indigo* (from aniline + monochloroacetic acid)	
			ix) Phthalocyanine Dyes: Monastral Fast Blue B	
	3.2		**Health and Environmental Hazards of Synthetic Dyes and their Remediation Processes**	**(3L)**
		3.2.1	**Impact of the textile and leather dye Industry on the environment** with special emphasis on water pollution	
		3.2.2	**Health Hazards:** Toxicity of dyes w.r.t food colours.	
		3.2.3	**Effluent Treatment Strategies**: Brief introduction to effluent treatment plants (ETP) Primary Remediation processes:(Physical Processes) Sedimentation, Aeration, Sorption (activated charcoal, fly ashetc.) Secondary Remediation processes: Biological Remediation – Biosorption, bioremediation and biodegradation Chemical Remediation: Oxidation Processes (chlorination), Coagulation-flocculation-Precipitation	

Unit – IV (Dyes)

4	**4.1**		**Non-textile uses of dyes:**	**(8L)**
		4.1.1	**Biomedical uses of dyes** i) Dyes used in formulations (Tablets, capsules, syrups etc) Indigo carmine, Sunset yellow, Tartrazine ii) Biological staining agents Methylene blue, Crystal violet and Safranine T iii) DNA markers Bromophenol blue, Orange G, Cresol red iv) Dyes as therapeutics Mercurochrome, Acriflavine, Crystal Violet, Prontosil	
		4.1.2	**Dyes used in food and cosmetics:** i) Properties of dyes used in food and cosmetics ii) Introduction to FDA and FSSAI iii) Commonly used food colours and their limits	
		4.1.3	**Paper and leather dyes** i) Structural features of paper and leather ii) Dyes applicable to paper and leather	
		4.1.4	**Miscellaneous dyes** i) Hair dyes ii) Laser dyes iii) Indicators iv) Security inks iv) Coloured smokes and camouflage colours	
	4.2		**Pigments**	**(3L)**
			Definition of pigments, examples, properties of pigments, difference between dyes and pigments. Definition of Lakes and Toners	
	4.3		**Dyestuff Industry - Indian Perspective**	**(4L)**
		4.3.1	Growth and development of the Indian Dyestuff Industry	
		4.3.2	Strengths, Weaknesses, Opportunities and Challenges of the Dyestuff industry in India	
		4.3.3	Make in India - Future Prospects of the Dye Industry	

References (For Units III & IV)

1. Chemistry of Synthetic Dyes, Vol I – IV, Venkatraman K., Academic Press 1972
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995
3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973
4. Environmental Studies, Joseph Benny, Tata McGraw Hill Education, 2005
5. Fundamental Concepts of Environmental Chemistry,Sodhi. G. S**.,** Alpha Science International, 2009
6. Planning Commission, Niti Aayog, FSSAI and FDA websites
7. Green Chemistry for Dyes Removal from Waste Water- Research Trends and Applications, Ed. Sharma S.K., Wiley, 2015
8. Environmental Pollution- Monitoring and Control, Khopkar S.M., New Age International (P) Ltd, New Delhi, 1982

Practicals

SEMESTER V

(Drugs and Dyes)

COURSE CODE: USACDD6P1 **CREDITS: 02**

1. O-Methylation of β-naphthol.
2. Preparation of Paracetamol form p-aminophenol.
3. Preparation of Fluorescein
4. TLC of a mixture of dyes (safranine-T, Indigo carmine, methylene blue)

II] Preparation of monograph of any one drug from syllabus by I.P. method.

OR

Industrial visit Report.

Program Specific Outcomes (PSO's)

On completion of B.Sc. [write program along with discipline eg. BA Psychology or B.Sc. Chemistry etc. and plan PSO as per subject's requirement] program, learners will be enriched with knowledge and be able to

PSO1	Demonstrate in-depth knowledge of electrochemical cells, activity coefficients, and overvoltage phenomena, enabling students to analyze and predict the behavior of electrochemical reactions in various systems.
PSO2	Apply advanced knowledge of Thin Layer Chromatography (TLC) to separate, identify, and analyze chemical compounds. Develop proficiency in selecting adsorbents, solvents, and conditions to optimize chromatographic separations.
PSO3	Interpret infrared spectra of organic compounds with an understanding of characteristic absorption bands for functional groups like alkanes, aromatics, carbonyls, and amines. Use this knowledge to deduce molecular structures and functional groups.
PSO4	Combine principles from electrochemistry, chromatography, and spectroscopy to tackle interdisciplinary challenges in chemical analysis, pharmaceuticals, environmental science, and material science.

T.Y.B.Sc. (CHEMISTRY)

TOOLS & TECHNIQUES IN CHEMISTRY (SEMESTER V)

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
UMMCH S5-311	Paper I	02	2
	Unit I : PHYSICAL CHEMISTRY MOLECULAR SPECTROSCOPY	15 Lectures	
	Unit II: ANALYTICAL CHEMISTRY Qualitative & Quantitative Analysis	15 Lectures	
		30 Lectures	

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

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
UMMCH S6-311	Paper I	02	2
	Unit I : PHYSICAL CHEMISTRY ELECTROCHEMISTRY	15 Lectures	
	Unit II: ANALYTICAL CHEMISTRY Qualitative & Quantitative Analysis	15 Lectures	
		30 Lectures	

Detailed Syllabus: Unit wise / Module wise with number of lectures Course title:

Physical and Analytical Chemistry

Course code:

Objective: To understand and develop competence in use of Basic mechanics and Thermodynamics.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1 Apply the concept of moment of inertia to calculate energy levels in rotational spectra.

LO2 Interpret rotational spectra and determine internuclear distances through simple numerical applications.

LO3 Understand zero-point energy and selection rules governing vibrational transitions.

LO4 Interpret infrared spectra of simple molecules like H_2O and CO_2, solving related numerical problems

LO5 Demonstrate knowledge of NMR spectrometer instrumentation and its applications.

LO6 Explain the principle of electron spin resonance, including the g-value and hyperfine splitting.

LO7 Apply gravimetric principles to chemical analysis, considering factors like precipitation, coagulation, and co precipitation.

LO8 Analyze the types of photometric titrations with examples and discuss their applications in quantitative analysis

Course title: Physical and Analytical Chemistry SEM V Course code: VESUSCH501

Unit no.	Details of topics	No of lectures
1	MOLECULAR SPECTROSCOPY 1) Rotational Spectrum: Introduction to dipole moment, polarization of a bond, bond moment, molecular structure, Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of inter nuclear distance (simple numerical, no derivation only final expression) 2) Vibrational spectrum: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero-point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum. (simple numerical, No derivation only final expression) 3) Vibrational-Rotational spectrum of diatomic molecule: energy levels, selection rule, nature of spectrum, P and R branch lines. Application of vibrational-rotational spectrum in determination of force constant and its significance. Infrared spectra of simple molecules like H2O and CO2. (simple numerical, no derivation only final expression) 4) Raman Spectroscopy: Scattering of electromagnetic radiation,	15

	Rayleigh scattering, Raman scattering, nature of Raman spectrum, Stoke's lines, anti-Stoke's lines, Raman shift, quantum theory of Raman spectrum (derivation expected), comparative study of IR and Raman spectra, rule of mutual exclusion- CO2 molecule. (no numerical) 5) NMR -NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY Principle: Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession, Relaxation processes in NMR (spin -spin relaxation and spin - lattice relaxation). Instrumentation: NMR Spectrometer 6) ELECTRON SPIN RESONANCE SPECTROSCOPY Principle: fundamental equation, g-value -dimensionless constant or electron g-factor, hyperfine splitting. Instrumentation: ESR spectrometer,	
UNIT 2	Qualitative & Quantitative Analysis 2.1 Quality in Analytical chemistry 2.1.1. Concepts in Quality,Quality control and Quality Assurance 2.1.2. Quality of materials:Various grades of laboratory reagents 2.1.3. Theories of acid-base indicators (Ostwalds'), redox indicators(Diphenylamine and ferroin), Metallohromic indicators (With suitable examples) (titration Curves not expected) 2.1.4. Importance of various steps in gravimetric analysis: precipitation, coagulation, peptization, co -precipitation, post precipitation, Role of digestion, filtration and washing of precipitate, drying and ignition. 2.2-Instrumental methods 2.2.1-Flame emission Spectroscopy and Atomic absorption Spectroscopy-Introduction,Principle , Instrumentation and Applications 2.2.2. Photometric titrations: Principle, Instrumentation, Types of photometric titrations with suitable examples, Applications.	15L

CHEMISTRY PRACTICALS **Semester 05**

Unit no.	Details of topics	No of lectures
	1.Potentiometry To determine the solubility product and solubility of AgCl potentiometrically using chemical cell	
	2. Conductometry To investigate the conduct metric titration one of the Strong base against weak acid	

	3. Conductometry To determine the velocity constant of alkaline hydrolysis of ethyl acetate by conductometric method.	
	4.**Redox titrations** a.Preparation and Standardisation of 0.025 NFe(II) ammonium sulphate b.Estimation of COD in a given water sample	
	5. **Gravimetric estimation** : To estimate lead as lead sulphate	
	6.**Thin Layer Chrmatography** :To perform the separation and analysis of sugars by using thin layer chromatography (TLC)	

Detailed Syllabus: Unit wise / Module wise with number of lectures Course title: Physical and Analytical Chemistry

Course code: UMMCH5-313

Objective: To understand and develop competence in use of Physical and analytical Chemistry.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Explain ionic strength, mean ionic activity, and mean ionic activity coefficient of electrolytes.
LO2	Apply the Debye-Huckel limiting law to express the activities of electrolytes.
LO3	Classify different types of electrochemical cells, including chemical and concentration cells.
LO4	Differentiate between chemical cells with and without transference.
LO5	Understand the concept of decomposition potential and identify factors affecting it.
LO6	Demonstrate the experimental procedures involved in TLC

Course title: Physical and Analytical Chemistry SEM VI Course code: UMMCH6-313

Unit no.	Details of topics	No of lectures
1	ELECTRO CHEMISTRY 1) Activity and Activity Coefficient: Lewis concept, ionic strength, mean ionic activity and mean ionic activity coefficient of an electrolyte, expression for activities of electrolytes. Debye Huckel limiting law (No derivation). 2) Classification of cells: Chemical cells and Concentration cells. Chemical cells with and without transference, Electrode Concentration cells, Electrolyte concentration cells with and without transference (derivations are not expected), 1. 3) Polarization: concentration polarization and its elimination 4) Decomposition Potential and Overvoltage: Introduction, experimental determination of decomposition potential, factors affecting decomposition potential. 5) Tafel's equation for hydrogen overvoltage, experimental determination of over –voltage	**15**
UNIT 2	**2.1 Thin layer Chromatography (TLC): (8L)** Advantages. Principles and factors affecting Rf values. Experimental procedures. Adsorbents and solvents. Preparation of plates. Development of the chromatogram. Detection of the spots. Applications. Column Chromatography: Principles, Experimental Procedures, Stationary and mobile Phases, and Separation Techniques. Applications **2.2 Infrared spectroscopy (7L)**	15 Lectures
	Different Regions in Infrared radiations. Characteristic absorption bands of various functional groups. Interpretation of spectra-Alkanes, Aromatic, Alcohols carbonyls, and amines with two examples of each.	

CHEMISTRY PRACTICALS **Semester 06**

Unit no.	Details of topics	Credits(02)
	1. **Potentiometry** To determine the number of electrons in the redox reaction between ferrous ammonium sulphate and cerric sulphate potentiometrically. 2.**Conductometry/ Potentiometry** To determine the concentrations of strong acid and weak acid present in the mixture by titrating with strong base 3.**Colorimetry** To estimate the amount of Fe(III) in the complex formation with salicylic acid by Static Method	
	4. **Colorimetry** : Estimation of Mn (II) by periodate 5. **IR Spectral Analysis** of the following functional groups with examples a) Hydroxyl groups b) Carbonyl groups 6. **IR Spectral Analysis** of the following functional groups with examples a) Amino groups b) Aromatic groupsc)	

References

REFERENCES THEORY

1. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co.Ltd.

2. Physical Chemistry, P.C. Rakshit, 6th Edition, 2001, Sarat Book Distributors, Kolkota.

3. Physical Chemistry, R.J. Silbey, & R.A. Alberty, 3rd edition , John Wiley & Sons, Inc [part 1]

4. Physical Chemistry, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House.

5. Modern Electrochemistry, J.O.M Bockris & A.K.N. Reddy,

Maria Gamboa – Aldeco 2nd Edition, 1st Indian reprint,2006 Springer

6. Fundamental of Molecular Spectroscopy, 4 th Edn., Colin N Banwell and Elaine M McCash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.

7. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.

8. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition, Oxford Universtity Press Oxford.

9. Physical Chemistry, G.K. Vemullapallie, 1997, Prentice Hall of India, Pvt.Ltd. New Delhi.

10. Principles of Physical Chemistry B.R. Puri, L.R. Sharma, M.S. Pathania, VISHAL

11. Spectroscopy by William Kemp

12. Spectroscopy by Pavia

Detailed Syllabus: Unit wise / Module wise with number of lectures
Course title: INDUSTRIAL MANUFACTURING PROCESSES (VSC)

Course code: UVSCHS5-326

Objective: To understand and develop competence in use of **INDUSTRIAL MANUFACTURING PROCESSES**

Learning Outcomes:

On successful completion of this course students will be able to:

LO1	Prepare various chemical compounds such as Ferrous sulphate heptahydrate, Aspirin, and Copper sulphate pentahydrate using micro-scale methods.
LO2	Gain practical experience in green synthesis processes, as exemplified in the synthesis of benzilic acid from benzil.
LO3	Understand the principles of complex formation through preparation of the Ni-DMG complex and ferric alum.
LO4	Master methods for quantitative analysis through estimations using titrimetry and back titration techniques.
LO5	Analyze acid-base solutions effectively using appropriate indicators (1-naphtholphthalein and phenolphthalein) for standardization of solutions.
LO6	Develop proficiency in techniques such as back titration for estimating the concentration of substances like methyl salicylate and Ibuprofen.
LO7	Accurately interpret and report experimental data to draw valid conclusions about the preparation and estimation of substances.

Preparations (Micro scale)

1.Preparation of Ferrous sulphate heptahydrate
2.Preparation of Aspirin
3.Green synthesis of benzillic acid from benzil
4.Double salt (Ferric alum)
5.Copper sulphate pentahydrate
6. Preparation of Ni-DMG complex

Estimations

1.Estimation of tincture iodine.
2.Estimation of methyl salicylate .(Back titration method)
3.Estimation of acetic acid in a sample of vinegar (Titrimetry)
4.Determination of the amount of. phosphoric acid from a given sample using 1 - naphtholphthalein and phenolphthalein indicator.(Students to prepare succinic acid solution for standardization of NaOH).
5.Determination of the amount of magnesium hydroxide in a commercial sample of milk of magnesia.
6.Estimation of aspirin (Acid-Base titration)
7.Estimation Ibuprofen in the given sample (Back titration method)

Recommended Books

1. C. D. Dryden: Outlines of Chemical Technology, edited & revised by M. Gopala Rao & Marshall Sittig East West Press, New Delhi.
2. Faith Keyes and Clerk‘s Industrial Chemicals, 4th Edn., Wiley Inter-science 1975.
3. Kirk & Othmer: Encyclopeadia of Chemical Technology, John Wiley and sons.
4. A. I. Vogel: Text book of Quantitative Analysis including Instrumental Analysis.
5. A. I. Vogel: Text book of Quantitative Organic Analysis.
6. Industrial Inorganic Chemistry-Buchner, Schliebs, Winter, translated by D. H. Tenell, VCH Publishers, New York.
7. Industrial Organic Chemistry- K. Welssermel, H. J. Arpe, VCH Publishers, New York.
8. B.Pearson- Speciality Chemical Innovations in Industrial Synthesis.
9. Text Book of Organic Medicinal and Pharmaceutical Chemistry Wilson & Giswold
10. Text Book of Pharmacology – Satoskar & Bhandarkar.
11. The Chemistry of Synthetic Dyes – Edited by K. Venkatraman. Academic press Inc. London.
12. Shreeves _Chemical Process Industries‘ 5th Edition, G. T. Oustin, McGraw Hill.
13. Industrial Chemistry- B. K. Sharma, Goyal publishing house, Mirut.
14. Riegel‘s Hand Book of Industral Chemistry, 9th Edition, Jems A. Kent.
15. Industrial Chemistry- E Stoch, Vol- I, Ellis Horwood Ltd. UK.
16. An Introduction to Industrial Organic Chemistry- Wiseman and Peter, —‖

Detailed Syllabus: Unit wise Module wise with number of lectures

Course title: Minor Chemistry (Essentials of Chemistry I)
Course code: UMNCHS5-316
Objective: To understand general principles of chemistry

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Students will be acquainted with different types of radioactive decay (alpha, beta, gamma) and the concept of half-life and unit of radioactivity.
LO2	Students will learn to Identify various methods and instruments used to detect and measure radiation (e.g., Geiger counters, scintillation counters) and understand their applications.
LO3	Students will be acquainted to differentiate between physical and chemical adsorption by understanding and applying adsorption isotherm models.
LO4	Students will be acquainted to describe the principles behind complexometric titrations using EDTA (ethylenediaminetetraacetic acid) and factors to enhance selectivity of EDTA as Titrant.
LO5	Students will be acquainted with the use of metallochromic indicators like Eriochrome Black T and Murexide.
LO6	Explain the principles of turbidimetry and nephelometry and the factors that affect radiation scattering.
LO7	Learners will understand the basic principles of solid state chemistry, various packing factors for different cubic crystals.
LO8	Learners will gain knowledge of lanthanides and their applications.
LO9	Learners will understand the importance of agrochemicals and its synthesis.
LO10	Learners will understand the concept of green chemistry and its significance in sustainability.

T.Y.B.SC. Semester V		
Course Code: **UMNCHS5-316** Minor Chemistry (Essentials of Chemistry I)	Credits & Lectures per Semester 02	Lectures per Week 02
Unit 01 (Physical & Analytical) **Physical Chemistry(8L)** **1. NUCLEAR CHEMISTRY(4L)**: basic terms-radioactive constants(decay constant,half life and average life) and units of radioactivity Detection and measurement of radioactivity using G.M. counter and Scintillation counter. Chemical reaction mechanism ,age determination-dating by C^{14}. artificial radioactivity , **2. SURFACE CHEMISTRY(4L)**, Adsorption :Physical and Chemical Adsorption, types Adsorption isotherms, Langmuir and Fredulich adsorption isotherm (Postulates and derivation expected) B.E.T equation for multilayer adsorption ,(derivation not expected). Determination of surface area of adsorbent using B.E.T equation. **Analytical Chemistry(7L)** **1. COMPLEXOMETRIC TITRATION**(3L): Classical method of analysis,Use of EDTA as titrant and factors enhancing selectivity with examples. Advantages and limitations of EDTA as a titrant. Metallochromic indicators, theory, examples and application. **2.OPTICAL METHODS- I (4L)**: Introduction and principle of Turbidimetry and Nephelometry.Factors affecting scattering of radiations: Concentration,Particle size ,Wavelength,refractive Index Instrumentation and Applications	15L	1L
Unit 02 **Inorganic Chemistry (8L)** **1.STRUCTURES OF SOLIDS (3L)**, Explanation of terms viz.crystal lattice, lattice point, unit cell and lattice constants Closest packing of rigid spheres (hcp,ccp), packing density in simple cubic, bcc and fcc lattices. **Chemistry of Inner transition elements (3L)** Electronic configuration of Lanthanides Lanthanide Contraction, Complex formation, Oxidation States, Magnetic properties, Applications of Lanthanides. **2.CHEMISTRY OF NON-AQUEOUS SOLVENTS** (2L): Classification of solvents and importance of non-aqueous solvents. Characteristics and study of liquid ammonia, dinitrogen tetroxide as non-aqueous solvents with respect to :(i) acid-base reactions and (ii) redox reactions. **Organic Chemistry (7L)** **1.AGROCHEMICALS (4 L)** General introduction & scope, meaning & examples of insecticides,	15L	1L

herbicides, fungicide, rodenticide, pesticides, plant growth regulators. Advantages & disadvantages of agrochemicals,Synthesis & application of IAA (Indole Acetic Acid) & Endosulfan, Bio pesticides – Neem oil & Karanj oil. **2.GREEN CHEMISTRY AND SYNTHESIS:(3L)** Introduction: Twelve principles of green chemistry, concept of atom economy and E-factor, calculations and their significance, numerical examples. i) Green reagents: dimethyl carbonate. ii) Green starting materials : D-glucose iii) Green solvents : supercritical CO2 iv) Green catalysts: Bio catalysts.		

Practicals in Minor Chemistry Semester V ;
Course Code: UMNCHS5-317

1	To determine the order between $K_2S_2O_8$ and KI by the fractional change method.	
2	To determine the solubility product and solubility of AgCl potentiometrically using chemical cells.	
3	To investigate the adsorption of acetic acid on activated charcoal and test the validity of the Freundlich adsorption isotherm.	
4	Preparation of bisacetylacetonatocopper(II)	
5	Preparation of ferrous ethylene diammonium sulfate.	
6	Determination of percentage purity of the given water-soluble salt and qualitative detection w.r.t. added cation and/or anion (qualitative analysis only by wet tests). (Any three salts of transition metal ions) (Standardization of EDTA solution not required) For Semimicro analysis, Water soluble cations like $K^+/NH4^+$ may be given, and anions may be Cl^-,NO_3^{-2} , SO_4^{-2}	
7	Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests). (Any three salts of transition metal ions) (Standardization of EDTA solution not required) For Semimicro analysis, Water soluble cations like $K^+/NH4^+$ may be given and anions may be Cl^-,NO_3^{-1} , SO_4^{-2}	
8	Determination of percentage purity of the given water-soluble salt and qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests). (Any three salts of transition metal ions) (Standardization of EDTA solution not required) For Semimicro analysis, water-soluble cations like $K^+/NH4^+$ may be given and anions may be Cl^-,NO_3^{-1} , SO_4^{-2} .	

9	To determine the amount of sulfate in the given water sample turbidimetrically	
10	To estimate magnesium content in talcum powder by using the standard solution of EDTA.	
11	Preparation of Aspirin from salicylic acid. .	
12	To synthesize benzilic acid from Benzil under solvent free condition	
13	To determine the amount of $Mg(OH)_2$ in the given commercial sample of magnesia.	

SEM_6

Course title: Minor Chemistry (General Principles of Chemistry II)

Course code: UMNCHS6-316

Objective: To understand and develop competence in use of Basics of chemistry. Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Students will learn to calculate molar masses of polymers by viscosity method
LO2	Students will be acquainted with the fundamental principles of photovoltaic energy conversion and to understand how they use hydrogen as fuel cells for generation of electricity and their applications.
LO3	Students will be acquainted to discuss ion exchange chromatography, the principles of ion exchangers, and the factors affecting ion separation.
LO4	Learners will gain insight into instrumentation of differential thermal analysis and thermogram.
LO5	Learners will be able to compare homogeneous and heterogeneous catalysis with respect to wilkinson catalyst.
LO6	Learners will understand and discuss the role of organometallic compounds in coordination chemistry, including ligand types and bonding.
LO7	Learners will know the importance of catalyst and reagents used in reaction
LO8	Learners will gain knowledge of molecular rearrangement and its stereochemistry.

T.Y.B.SC. Semester VI		
Course Code: **UMNCHS6-316** **Minor Chemistry (Essential of Chemistry II)**	Credits & Lectures per Semester 02	Lectures per Week 02
Unit 01 Physical Chemistry (08L) **1. POLYMERS (4L**):Basic terms: macromolecule, monomer, repeat unit, degree of polymerization. Molar masses of polymers: Number average, Weight average, Viscosity average molar mass, Monodispersity and Polydispersity Method of determining molar masses of polymers : Viscosity method using Ostwald Viscometer. (No derivation expected) **2.RENEWABLE ENERGY RESOURCES(4L):** Solar cell,photovoltaic effect. Difference between conductors, semiconductors, insulators and its band gap, Hydrogen fuel of the future, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium. Analytical Chemistry (07L) **1. ION EXCHANGE CHROMATOGRAPHY(3L)** - Introduction, Principle. Types of Ion Exchangers , Ideal properties of resin,Factors affecting separation of ions,Application with reference to separation and determination of Magnesium and Zinc. **2.THERMAL METHODS AND ANALYTICAL METHOD VALIDATION (4L)** Instrumentation-block diagram,thermobalance (Basic components: balance, furnace, temperature measurement and control, recorder) Thermogram (TG curve)forCaC2O4..H2O and CuSO4.5H2O Factors affecting thermogram-Instrumental factors and Sample characteristics Differential Thermal Analysis (DTA):Principle, Instrumentation, and Reference material used Differential thermogram (DTA curve) CaC2O4 .H2O and CuSO4.5H2O Applications Comparison between TGA and DTA.	15L	1L
Unit 02 INORGANIC CHEMISTRY (8L) **1.CATALYSIS** (4L):Comparison between homogeneous and heterogeneous catalysis. Basic steps involved in homogeneous catalysis Mechanism of Wilkinson's catalyst in hydrogenation of alkenes. **2 ORGANOMETALLIC COMPOUNDS OF MAIN GROUP METAL (4L)** General characteristics of various types of organometallic	15L	1L

compounds, viz.ionic, -bonded and electron deficient compounds.
Some chemical reactions of organometallic compounds:
(i) Reactions with oxygen and halogens,
(ii) Alkylation and arylation reactions
(iii) Reactions with protic reagents,
(iv) Redistribution reactions and
(v) Complex formation reactions.

Organic Chemistry (7L)

Amino acids & Proteins (03 L)

- α-Amino acids: General Structure, configuration, and classification Based on structure and nutrition. Properties: pH dependence of ionic structure, isoelectric point and zwitterion.
- Polypeptides and Proteins: nature of peptide bond. Nomenclature and representation of polypeptides (di-and tripeptides)
- Proteins: general idea of primary, secondary, tertiary & quaternary structure.
- Importance of Amino Acids and Proteins

Nucleic Acids (02 L)

- Controlled hydrolysis of nucleic acids. sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA. Structures of nucleic acids (DNA and RNA) including base pairing.

Catalysts and Reagents (02 L)

- Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism).
- **Catalysts: Catalysts for hydrogenation:**
    1. Raney Nickel
    2. Pt and PtO2 (C=C, CN, NO2, aromatic ring)
    3. Pd/C : C=C,
- **Reagents**:
    1. SeO2 (Oxidation of CH2 alpha to CO)
    2. mCPBA (epoxidation of C=C)
    3. NBS (allylic and benzylic bromination)

Practicals in Minor: **UMNCHS6-317**

Chemistry Semester VI

1	To determine acidic and basic dissociation constants of amino acid and hence to calculate isoelectric point	
2	To determine the molecular weight of high polymer polyvinyl alcohol (PVA) by viscosity measurement.	
3	Preparation of Tris(acetylacetonato) iron(III)	
4	Green synthesis of bis(dimethylglyoximato) nickel(II) complex using nickel carbonate and sodium salt of dmg .	
5	Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests). (Any three salts of transition metal ions) (Standardization of EDTA solution not required) For Semimicro analysis, Water soluble cations like K^+/ NH_4^+ may be given and anions may be Cl^-,NO_3^- , SO_4^{2-}	
6	Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests). (Any three salts of transition metal ions) (Standardization of EDTA solution not required) For Semimicro analysis, Water soluble cations like K^+/ NH_4^+ may be given and anions may be Cl^-,NO_3^- , SO_4^{2-}	
7	Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests). (Any three salts of transition metal ions) (Standardization of EDTA solution not required) For Semimicro analysis, Water soluble cations like K^+/ NH_4^+ may be given and anions may be Cl^-,NO_3^{-1} , $SO^{-2}{}_4$	
8	Preparation of Anthraquinone from Anthracene	
9	O-Methylation of β-naphthol	
10	Preparation of Paracetamol from p-aminophenol	
11	To estimate phosphoric acid present in the given sample	
12	Estimation of Mg^{+2} and Zn^{+2} using an anion exchange resin	
13	To determine the percentage of acetic acid in vinegar.	

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4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
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Analytical Chemistry:

1. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch
2. Instrumental methods of analysis by Willard, H.H.; Merritt, L.L. Jr. Dean, J.A.; Settle,7th Edition
3. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch
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6. S.M. Khopkar, “ Basic Concepts of Analytical Chemistry”, IInd Edition NewAge International Publisher.
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Unit 02

Inorganic Chemistry:

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2. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition

3. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt,. Ltd. (2002).
4. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS
5. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999)
6. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
7. R. Gopalan, Universities Press India Pvt. Ltd. Inorganic Chemistry for Undergraduates.

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2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
4. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
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