



MANONMANIAM SUNDARANAR UNIVERSITY -TIRUNELVELI
PG PROGRAMMES



OPEN AND DISTANCE LEARNING (ODL) PROGRAMMES

(FOR THOSE WHO JOINED THE PROGRAMMES FROM THE ACADEMIC YEAR 2023–2024)

M.Sc. Chemistry

Semester	Course	Title of the Course	Course Code
II	Core V	Organic Reaction Mechanism – II	SCHM21
	Core VI	Physical Chemistry – I	SCHM22
	Core VII	Organic Chemistry Practical - II	SCHP21
	Core VIII	Inorganic Chemistry Practical - I	SCHP22
	Elective - III	Green Chemistry	SCHE21
	Elective – IV	Bio Inorganic Chemistry	SCHE22
	Skill Enhancement	Industrial Chemistry	SCHS21

ORGANIC REACTION MECHANISM - II

UNIT	DETAILS
I	<p>Elimination and Free Radical Reactions: Mechanisms: E2, E1, and E1cB mechanisms. Syn- and anti-eliminations. Orientation of the double bond: Hoffmann and Saytzeff rules. Reactivity: Effect of substrate, attacking bases, leaving group and medium. Stereochemistry of eliminations in acyclic and cyclic systems, pyrolytic elimination. Long lived and short-lived radicals – Production of radicals by thermal and photochemical reactions, Detection and stability of radicals, characteristics of free radicals, Reactions of radicals: polymerization, addition, halogenations, aromatic substitutions, rearrangements. Reactivity: Reactivity on aliphatic, aromatic substrates, reactivity in the attacking radical, effect of solvent.</p>
II	<p>Oxidation and Reduction Reactions: Mechanisms: Direct electron transfer, hydride transfer, hydrogen transfer, displacement, addition-elimination, oxidative and reductive coupling reactions.</p> <p>Mechanism of oxidation reactions: Dehydrogenation by quinones, selenium dioxides, ferricyanide, mercuric acetate, lead tetraacetate, osmium tetroxide, Reactions involving cleavage of C-C bonds - cleavage of double bonds, oxidative decarboxylation, allylic oxidation, oxidation by chromiutrioxide - pyridine, DMSO-Oxalyl chloride (Swern oxidation) and Corey- Kim oxidation, dimethyl sulphoxide- dicyclohexyl carbodiimide (DMSO-DCCD)</p> <p>Mechanism of reduction reactions: Wolff-Kishner, Clemmenson, Rosenmund, reduction with Trialkyl and triphenyltin hydrides, Homogeneous hydrogenation, Hydroboration with cyclic systems, MPV and Bouveault-Blanc reduction.</p>
III	<p>Rearrangements:</p> <p>Rearrangements to electron deficient carbon: Pinacol – pinacolone and semi-pinacolone rearrangements - applications and stereochemistry, Wagner-Meerwein, Demjanov, Dienone-phenol, Benzilic acid and Wolff Rearrangements.</p> <p>Rearrangements to electron deficient nitrogen: Hofmann, Curtius, Schmidt, Lossen, Beckmann and abnormal Beckmann rearrangements.</p> <p>Rearrangements to electron deficient oxygen: Baeyer-Villiger oxidation and Dakin rearrangements.</p> <p>Rearrangements to electron rich atom: Favorskii, Quasi-Favorskii, Stevens, [1,2]-Wittig and [2,3]-Wittig rearrangements. Fries and Photo Fries rearrangement.</p> <p>Intramolecular rearrangements: Claisen, abnormal Claisen, Cope, oxy-Cope and Benzidine rearrangements.</p>
IV	<p>Addition to Carbon Multiple Bonds:</p> <p>Mechanisms: Addition to carbon-carbon multiple bonds: Addition reactions involving electrophiles, nucleophiles, free radicals, carbenes and cyclic mechanisms-Orientation and reactivity, hydrogenation of double and triple bonds, Michael reaction, addition of oxygen and Nitrogen.</p> <p>Addition to carbon-hetero atom multiple bonds: Mannich reaction, acids, esters, nitrites, addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds, Wittig reaction, Prins reaction. Stereo chemical aspects of addition reactions. Mechanism of condensation reactions involving enolates –Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.</p>

V	<p>Reagents and Modern Synthetic Reactions: Lithium diisopropylamine (LDA), Sodium cyanoborohydride (NaBH₃CN), <i>meta</i>-Chloroperbenzoic acid (m-CPBA), Dimethyl aminopyridine (DMAP), n-Bu₃SnD, Triethylamine (TEA), Diethylazodicarboxylate (DEAD), <i>N</i>-bromosuccinimide (NBS), Trifluoroacetic acid (TFA), Phenyl trimethyl ammonium tribromide (PTAB). Diazomethane and Zn-Cu, Diethyl maleate (DEM), Copper diacetylacetonate (Cu(acac)₂), TiCl₃, NaIO₄, Pyridinium chlorochromate (PCC), Pyridinium dichromate (PDC), Meisenheimer complex. Suzuki coupling, Heck reaction, Negishi reaction, Baylis-Hillman reaction.</p>
Recommended Text	
1	J. March and M. Smith, <i>Advanced Organic Chemistry</i> , 5th ed., John-Wiley and Sons. 2001.
2	E. S. Gould, <i>Mechanism and Structure in Organic Chemistry</i> , Holt, Rinehart and Winston Inc., 1959.
3	P. S. Kalsi, <i>Stereochemistry of carbon compounds</i> , 8 th edn, New Age International Publishers, 2015.
4	P. Y. Bruice, <i>Organic Chemistry</i> , 7 th edn., Prentice Hall, 2013.
5	R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee <i>Organic Chemistry</i> , 7 th edn., Pearson Education, 2010.

PHYSICAL CHEMISTRY-I

UNIT	DETAILS
I	<p>Classical Thermodynamics: Partial molar properties- Chemical potential, Gibb's-Duhem equation-binary and ternary systems. Determination of partial molar quantities. Thermodynamics of real gases - Fugacity- determination of fugacity by graphical and equation of state methods-dependence of temperature, pressure and composition. Thermodynamics of ideal and non-ideal binary mixtures, Duhem - Margulus equation, applications of ideal and non-ideal mixtures. Activity and activity coefficients-standard states - determination-vapour pressure, EMF and freezing point methods.</p>
II	<p>Statistical thermodynamics: Introduction of statistical thermodynamics, concepts of thermodynamic and mathematical probabilities-distribution of distinguishable and non-distinguishable particles. Assemblies, ensembles, canonical particles. Maxwell -Boltzmann, Fermi Dirac & Bose-Einstein Statistics-comparison. Partition functions-evaluation of translational, vibrational and rotational partition functions for monoatomic, diatomic and polyatomic ideal gases. Thermodynamic functions in terms of partition functions- calculation of equilibrium constants. Statistical approach to Thermodynamic properties: pressure, internal energy, entropy, enthalpy, Gibb's function, Helmholtz function, residual entropy and equilibrium constants. Heat capacity of mono and diatomic gases-ortho and para hydrogen. Heat capacity of solids-Einstein and Debye models.</p>
III	<p>Irreversible Thermodynamics: Theories of conservation of mass and energy, entropy production in open systems by heat, matter and current flow, force and flux concepts. Onsager theory-validity and verification- Onsager reciprocal relationships. Electro kinetic and thermo mechanical effects-Application of irreversible thermodynamics to biological systems.</p>
IV	<p>Kinetics of Reactions: Theories of reaction rates -effect of temperature on reaction rates, collision theory of reaction rates, Unimolecular reactions. Lindeman and Christiansen hypothesis. Potential energy surfaces. Transition state theory-evaluation of thermodynamic parameters of activation-applications of ARRT to reactions between atoms and molecules. Factors determine the reaction rates in solution - primary salt effect and secondary salt effect, Homogeneous catalysis- acid- base catalysis-mechanism of acid base catalyzed reactions-Bronsted catalysis law, enzyme catalysis-Michelis-Menton catalysis.</p>
V	<p>Kinetics of complex and fast reactions: Kinetics of complex reactions, reversible reactions, consecutive reactions, parallel reactions, chain reactions. Chain reactions-chain length, kinetics of H_2-Cl_2 & H_2-Br_2 reactions (Thermal and Photochemical reactions) - RiceHerzfeld mechanism. Study of fast reactions-relaxation methods - temperature and pressure jump methods, electric and magnetic field jump methods -stopped flow, flash photolysis methods and pulse radiolysis. Kinetics of polymerization-free radical, cationic, anionic polymerization - Polycondensation</p>

Recommended Text	
1	J. Rajaram and J.C. Kuriacose, Thermodynamics for Students of Chemistry, 2nd edition, S.L.N.Chand and Co., Jalandhar, 1986.
2	I.M. Klotz and R.M. Rosenberg, Chemical thermodynamics, 6th edition, W.A. Benjamin Publishers, California, 1972.
3	M.C. Gupta, Statistical Thermodynamics, New Age International, Pvt. Ltd., New Delhi, 1995.
4	K.J. Laidler, Chemical Kinetics, 3rd edition, Pearson, Reprint -2013.
5	J. Rajaram and J.C. Kuriokose, Kinetics and Mechanisms of chemical transformation, M acmillan India Ltd, Reprint - 2011.

ORGANIC CHEMISTRY PRACTICAL - II

UNIT	DETAILS
I	<p>Estimations:</p> <ul style="list-style-type: none"> a. Estimation of Phenol (bromination) b. Estimation of Aniline (bromination) c. Estimation of Ethyl methyl ketone (iodimetry) d. Estimation of Glucose (redox) e. Estimation of Ascorbic acid (iodimetry) f. Estimation of Aromatic nitro groups (reduction) g. Estimation of Glycine (acidimetry) h. Estimation of Formalin (iodimetry) i. Estimation of Acetyl group in ester (alkalimetry)
II	<p>Two stage preparations:</p> <ul style="list-style-type: none"> a. <i>p</i>-Bromoaniline from acetanilide b. <i>p</i>-Nitroaniline from acetanilide c. 1,3,5-Tribromobenzene from aniline d. Benzilic acid from benzoin e. <i>m</i>-Nitroaniline from nitrobenzene f. <i>m</i>-Nitrobenzoic acid from methyl benzoate
Recommended Text	
1	A.I. Vogel Elementary Practical Organic Chemistry Small Scale Preparations, Qualitative Organic Analysis, Quantitative Organic Analysis Pearson Education, 2011.
2	F.G.Mann and B.C Saunders. Practical Organic Chemistry, 4 th edn Pearson Education India, 2009.
3	K. Bansal Raj, Laboratory Manual of Organic Chemistry, New Age International, 2009.
4	V. Venkateswaran, R. Veeraswamy and A.R Kulandaivelu, Basic Principals of Practical Chemistry, Sultan Chand & Sons, 2004.
5	V.K.Ahluwalia and R. Aggarwal, Comprehensive Practical Organic Chemistry, Universities Press, 2004.

INORGANIC CHEMISTRY PRACTICAL-I

UNIT	DETAILS
I	<p>Analysis of mixture of cations: Analysis of a mixture of four cations containing two common cations and two rare cations. Cations to be tested.</p> <p>Group-I : W and Pb. Group IA : Se, Te Group-II : Mo, Cu, Bi and Cd. Group-III : Ce, Th, Zr, V, Cr, and Ti. Group-IV : Zn, Ni, Co and Mn. Group-V : Ba and Sr. Group-VI : Li.</p>
II	<p>Complexometric Titration:</p> <ol style="list-style-type: none"> 1. Estimation of zinc, nickel, magnesium, and calcium. 2. Estimation of mixture of metal ions-pH control, masking and demasking agents. 3. Determination of calcium and lead in a mixture (pH control). 4. Determination of manganese in the presence of iron. 5. Determination of nickel in the presence of iron.
Recommended Text	
1	A.Jeya Rajendran, Micro analytical Techniques in Chemistry: Inorganic Qualitative Analysis, United global publishers, 2021.
2	V. V. Ramanujam, <i>Inorganic Semimicro Qualitative Analysis</i> ; 3rded., The National Publishing Company, Chennai, 1974.
3	Vogel's Text book of Inorganic Qualitative Analysis, 4thed., ELBS, London.
4	G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, Revised 5 th edition, ELBS, 1989.
5	Douglas A. Skoog, Donald M. West, F. James Holler and Stanley R. Crouch, Fundamentals of Analytical Chemistry, 8 th Edition, Brooks/Cole-Thomson Learning, USA, 2004.

GREEN CHEMISTRY

UNIT	DETAILS
I	Basic Principles of Green Chemistry: Introduction- Need for Green Chemistry. Goals of Green Chemistry. Limitations of Green Chemistry. Chemical accidents, terminologies, International green chemistry organizations and Twelve principles of Green Chemistry with examples.
II	Green Synthesis: Choice of starting materials, reagents, catalysts and solvents in detail, Green chemistry in day today life. Designing green synthesis-Green reagents: dimethyl carbonate. Green solvents: Water, Ionic liquids - criteria, general methods of preparation, effect on organic reaction. Supercritical carbon dioxide- properties, advantages, drawbacks and a few examples of organic reactions in scCO ₂ . Green synthesis-adipic acid and catechol.
III	Green Catalysis: Environmental pollution, Green Catalysis- Acid catalysts, Oxidation catalysts, Basic catalysts, Polymer supported catalysts-Poly styrene aluminum chloride, polymeric super acid catalysts, Polymer supported photosensitizers.
IV	Greener Reactions: Phase transfer catalysis in green synthesis-oxidation using hydrogen peroxide, crown ethers- esterification, saponification, anhydride formation, Elimination reaction, Displacement reaction. Applications in organic synthesis.
V	Green Techniques: Micro wave induced green synthesis - Introduction, Instrumentation, Principle and applications. Sonochemistry – Instrumentation, Cavitation theory - Ultra sound assisted green synthesis and Applications.
Recommended Text	
1	Ahluwalia, V.K. and Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers, 2005.
2	W. L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, 7 th edition, McGraw-Hill, New Delhi, 2005.
3	J. M. Swan and D. St. C. Black, Organometallics in Organic Synthesis, Chapman Hall, 1974.
4	V. K. Ahluwalia and R. Aggarwal, Organic Synthesis: Special Techniques, Narosa Publishing House, New Delhi, 2001.
5	A. K. De, Environmental Chemistry, New Age Publications, 2017.

BIO INORGANIC CHEMISTRY

UNIT	DETAILS
I	Essential trace elements: Selective transport and storage of metal ions: Ferritin, Transferrin and siderophores; Sodium and potassium transport, Calcium signaling proteins. Metalloenzymes: Zinc enzymes– carboxypeptidase and carbonic anhydrase. Iron enzymes– catalase, peroxidase. Copper enzymes – superoxide dismutase, Plastocyanin, Ceruloplasmin, Tyrosinase. Coenzymes - Vitamin-B12 coenzymes.
II	Transport Proteins: Oxygen carriers - Hemoglobin and myoglobin - Structure and oxygenation Bohr Effect. Binding of CO, NO, CN ⁻ to Myoglobin and Hemoglobin. Biological redox system: Cytochromes- Classification, cytochrome a, b and c. Cytochrome P-450. Non-heme oxygen carriers- Hemerythrin and hemocyanin. Iron-sulphur proteins- Rubredoxin and Ferredoxin- Structure and classification.
III	Nitrogen fixation: Introduction, types of nitrogen fixing microorganisms. Nitrogenase enzyme - Metal clusters in nitrogenase- Transition metal complexes of dinitrogen - nitrogen fixation via nitride formation and reduction of dinitrogen to ammonia. Photosynthesis: photosystem-I and photosystem-II- chlorophylls structure and function.
IV	Metals in medicine: Metal Toxicity of Hg, Cd, Zn, Pb, As, Sb. Therapeutic Compounds: Vanadium-Based Diabetes Drugs; Platinum - Containing Anticancer Agents. Chelation therapy; Cancer treatment. Diagnostic Agents: Technetium Imaging Agents; Gadolinium MRI Imaging Agents.
V	Enzymes - Introduction and properties - nomenclature and classification. Enzyme kinetics, free energy of activation and the effects of catalysis. Michaelis - Menton equation - Effect of pH, temperature on enzyme reactions. Factors contributing to the efficiency of enzyme.
Recommended Text	
1	Williams, D.R. – Introduction to Bioinorganic chemistry.
2	F.M. Fiabre and D.R. Williams– The Principles of Bioinorganic Chemistry, Royal Society of Chemistry, Monograph for Teachers-31
3	K.F. Purcell and Kotz., Inorganic chemistry, WB Saunders Co., USA.
4	G.N. Mugherjea and Arabinda Das, Elements of Bioinorganic Chemistry - 1993.
5	R. Gopalan, V. Ramalingam, <i>Concise Coordination Chemistry</i> , S. Chand, 2001.

INDUSTRIAL CHEMISTRY

UNIT	DETAILS
I	Paints and Pigments: General characteristics of pigments - Types of pigments, methods of preparation and properties of white pigments, Red pigments, Yellow pigments and Green pigments - Paints, varnishes and Lacquers – function and classification - Function of vehicle, solvent, thinner, pigment, dyes, filler, resins, drier and additives in paint formulations - epoxy coatings - Luminous paints.
II	Glass and Ceramics: Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass. Plasticity of clay – white wares – Glazing – applications.
III	Cementing Materials: Introduction - Lime and its manufacture – Gypsum Plaster. Cement, chemistry of raw materials used in cement manufacturing. Types of cement. - Manufacture of Portland cement - Chemical Composition of Portland Cement - Setting and Hardening of Portland Cement. Heat of Hydration of Cement - Special Cement – Concrete and RCC - Decay of Concrete.
IV	Petrochemicals: Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels - LPG, CNG, LNG, bio-gas, fuels derived from biomass.
V	Industrial Chemical Waste Management : Definition, Classification, sources and composition of solid, liquid and gaseous wastes, hazardous and non-hazardous wastes, special waste materials, Storage and transport of wastes, Transportation and collection systems. Management of wastes, minimization, reuse and recycling, Waste utilization and materials recovery. Treatment of wastes: biological treatment, composting, anaerobic digestion, combustion, Incineration, landfills and ultimate disposal.
Recommended Text	
1	J. Bentley and G.P.A. Turner, Introduction to Paint Chemistry and Principles of Paint Technology, Fourth edition, Springer US, 1998.
2	B.K. Sharma, Industrial Chemistry, Goel Publishing house, Meerut, 2000.
3	J. A. Kent, Riegel's Handbook of Industrial Chemistry, 9 th Edition (PB 1997), CBS Publishers, New Delhi
4	Peter Hewlett and Martin Liska, Lea's Chemistry of Cement and Concrete, Elsevier 2019.
5	N. K. Sinha, Petroleum refining and Petrochemical, Umesh Publication Delhi, 2003.
6	Dr. Ram Prasad, "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000.
7	C.S. Rao, "Environmental Pollution Control Engineering", New Age International Publishers; Third edition, 2018.

8	G. Tchobanoglous et al., Integrated Solid Waste Management, McGraw-Hill Publication, New York, 1993.
9	M.N. Rao, Sultana Razia and Kota Sri Harsha, Solid and Hazardous Waste Management, BS Publications 2017.
10	M. N Rao, Wastewater Treatment, Oxford & IBH Publishing; 3rd edition, 2020.
11	M.P. Poonia and S.C. Sharma, Industrial Safety and Maintenance Management, Khanna Book Publishing Company Pvt Ltd., 2019.