SNDT Women's University, Mumbai

Master of Science (Chemistry)
M. Sc. (Chemistry)

as per NEP-2020

Syllabus

(2023-24)

JV Gade
23/02/2024
BOS - Chairperson

Programme	**Master of Science** **M. Sc.**
Paranthesis	**Chemistry**
Preamble	To achieve excellence in the academic disciplines, research, and extension activities through an emphasis on "Quality in every activity. This includes providing access to the field of higher education for women, enabling students for research in emerging areas of study, and training and developing scientists and technologists for industries and academics. Additionally, we aim to address the socio-economic demands by offering job-oriented courses, ensuring a comprehensive approach to education and preparing individuals for a dynamic and competitive future. Providing Higher Education for Women, Developing and Research Attitudes in Women Students, Achieving Academic Discipline in Women, Achieving Orientated Courses and Research with Regional Industrial Needs, Developing a Basic Concept of Chemistry Applied in Industries
Programme Outcomes (POs)	After completing this programme, Learner will be able to 1. Implement practical to enhance women's skills in using advanced instruments. Provide workshops, seminars, and training programs to supplement theoretical knowledge with practical expertise. Create an environment that encourages experimentation, critical thinking, and innovation in the field of chemistry. 2. Conduct regular consultations with local industries to understand their specific needs and challenges. Adapt academic programs to address the skill gaps identified by local industries. 3. Collaborate with industry experts to design and update curriculum to match the requirements of the job market. Provide career counselling and guidance to help women align their skills and aspirations with industry demands.

	Facilitate internships, co-op programs, and industry-sponsored projects to give women practical exposure to real-world challenges. 4. Integrate entrepreneurship and business skills into the curriculum to encourage women to explore opportunities for self-employment. Provide resources and support for women to start their own ventures or contribute to existing businesses. Develop a mindset of economic independence and financial literacy among women students. 5. Implement outreach programs to bring education and training to rural and backward communities. 6. Encourage faculty and students to engage in applied research that addresses the specific challenges faced by local industries. Enable knowledge transfer between academia and industry to drive innovation and problem solving. By incorporating these considerations into your educational framework.
Programme Specific Outcomes (PSOs)	After completing this programme, Learner will be able to 1. Learn Various Skills, Including Handling Instruments and Advanced Analysis of Chemistry 2. Fulfil the Thrust of Industries in Our Area 3. Develop Women According to the Needs of Industries 4. Empower Women to Become Financially Independent 5. Empower Backward and Rural Women, Connecting Them to Modern Trends and Technical Knowledge 6. Develop Research in Industry to Meet Local Needs
Eligibility Criteria for Programme	B.Sc. graduate having Chemistry as main subject
Intake	30
Duration	4 semesters (2 years)

Master of Science in Chemistry (M. Sc. Chemistry)

Subject code	Courses	Type of Course	Credits	Marks	Int	Ext
	Semester I					
115311	Inorganic Chemistry	Major (Core) Theory	4	100	50	50
115312	Organic Chemistry	Major (Core) Theory	4	100	50	50
115313	Physical Chemistry	Major (Core) Theory	4	100	50	50
145311	Practical (Laboratory Course)	Major (Core) Practical	4	100	50	50
125311	Analytical Chemistry	Major (Elective) Theory	2	50	---	50
125312	Nuclear chemistry	Major (Elective) Theory				
125313	Polymer chemistry	Major (Elective) Theory				
135311	Research Methodology	Minor Stream (RM) Theory	4	100	50	50
			22	**550**	**300**	**250**
	Semester II					
215311	Inorganic Chemistry	Major (Core) Theory	4	100	50	50
215312	Organic Chemistry	Major (Core) Theory	4	100	50	50
215313	Physical Chemistry	Major (Core) Theory	4	100	50	50
245311	Practical (Laboratory Course)	Major (Core) Practical	4	100	50	50
225311	Analytical Chemistry	Major (Elective) Theory	2	50	---	50
225312	Nuclear Chemistry	Major (Elective) Theory				
225313	Polymer Chemistry	Major (Elective) Theory				
255311	Internship	OJT	4	100	50	50
			22	**550**	**250**	**300**

Exit option (44 credit):

Post Graduate Diploma in Chemistry

SEMESTER-I		
Code: 115311	**Course : Inorganic Chemistry Major (Core) Theory**	**Credits : 4**

Outcomes :

I) To understand the basic concepts of inorganic chemistry.
II) To develop expertise in collection, preparation & preservation of samples.
III) To prepare any standard solution.
IV) To acquire knowledge of theoretical concepts of volumetric techniques.

Module	Course Content	Credits
Module I	**Inorganic chemistry in biological systems : -** Essential and trace elements in biological systems and their functions, structure and function of metalloporphyrins, Hemoglobin, cytochrome and hemocyanine. Electron transfer, Respiration and photosynthesis reaction, Metal deficient diseases of Fe, Zn, Cu and Mn and their therapy.	01
Module II	**Chemical Bonding:-** Recapitulation of hybridization Derivation of wave functions for sp, sp^2 , sp^3 orbital hybridization types considering only sigma bonding , Discussion of involvement of d orbitals in various types of hybridizations. Concept of resonance, resonance energy derivation expected, Formal charge with examples, Critical analysis of VBT, Molecular Orbital Theory for diatomic species of First transition Series, Molecular Orbital Theory for Polyatomic species considering σ bonding for SF6, CO2, B2H6, I3 - molecular species, Weak forces of attraction: Hydrogen bonding – concept, types, properties, methods of detection and importance. Van der Waal's forces, ion-dipole, dipole-dipole, London forces	01
Module III	**Molecular symmetry and symmetry groups: –** symmetry elements and operations. Symmetry planes, reflections, inversion centre, proper/ improper axes of rotation, products of symmetry operations, equivalent symmetry elements and atoms, symmetry elements and optical isomerism, symmetry point groups, classes of symmetry operations, classification of molecular point groups.	01
Module IV	**Metal ligand equilibria in solution :-** Definition of stability constant, step wise and overall formation constant, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, Determination of formation constant for binary complexes using pH-metric technique.	01

Reference Books :

1. Symmetry and Group theory in Chemistry , R Ameta
2. Symmetry and Spectroscopy of Molecules, K.Veera Reddy.
3. Concise Inorganic Chemistry, J.D.Lee.
4. A Textbook of bioinorganic chemistry, A. K. Das.
5. Selected Topic in Inorganic Chemistry, Wahid U. Malik, G.D.Tuli and R.D.Madan.
6. Advanced Inorganic Chemistry, Volume I and II Gurdeep Raj.
7. Advanced Inorganic Chemistry, F.A.Cotton and Wilkinson.
8. Symmetry in Chemistry: H. Jaffe' and M. Orchin (2002).

SEMESTER –I		
Code: 115312	**Course : Organic Chemistry Major (Core) Theory**	**Credits : 4**

Outcomes : -

I) To describe the chemical and molecular processes that take place in organic chemical reactions.
II) To perform aliphatic nucleophilic substitution reactions.
III) To differentiate the various types of aliphatic nucleophilic substitution.
IV) To identify the stereochemical notations.
V) To explain concepts of organic acids & bases.

Module	Course Content	Credits
Module I	**Nature of Bonding in Organic Molecules :-** Delocalized chemical bonding, conjugation, cross conjugation, resonance, hyperconjugation, -molecular orbitals, annulenes,π tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternant and nonalternant compounds, Huckel rule, energy level of aromaticity, Bonds weaker than covalent - addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes.	01
Module II	**Reaction Mechanism :-** Structure and Reactivity Types of Mechanisms, Types of reactions, Thermodynamic and Kinetic requirements, Kinetic and Thermodynamic control, Hammond's postulate, methods of determining mechanisms, isotope effects.	01
Module III	**Stereo-chemistry :-** Elements of symmetry, chirality, Enantiomeric and diastereomeric relationships, R and S, E and Z nomenclature. Molecules with more than one chiral center, Threo and Erythro isomers, Prochiral relationships, groups and faces, stereospecific and stereoselective reactions. Optical activity in the absence of Chiral Carbon (Biphenyls, allenes and Spiranes), Chirality due to hellical shape. Methods of resolution, optical purity, stereochemistry of the compounds containing Nitrogen, Sulphur and phosphorous. Conformational analysis of cycloalkanes, Mono and disubstituted cyclohexanes, decalins, effect of conformation on Reactivity	01
Module IV	**Acids and Bases: -** Factors affecting acidity and basicity, Electronegativity and inductive effect, resonance, bond strength, electrostatic effects, hybridization, aromaticity and solvation. Comparative study of acidity and basicity of organic compounds on the basis of pKa values, Levelling effect and non-aqueous solvents. Acid and base catalysis , general and specific catalysis with examples.	01

Reference Books :

1. Advanced Organic Chemistry, IV Edition: Jerry March
2. Stereochemistry of Carbon Compounds: E. L. Eliel
3. Advanced organic Chemistry, Part-A and Part-B: F. A. Carey, & R. J. Sundburg.

4. A Guide Book to Mechanisum in Organic Chemistry: Peter Sykes.
5. Principles of Organic Synthesis: R. O. C. Norman
6. Stereochemistry of Organic Compounds: D. Nasipuri
7. Organic Chemistry: Clayden and Greeves
8. Mechanism and Structure in Organic Chemistry: E. S. Gould

SEMISTER –I		
Code: 115313	**Course : Physical Chemistry Major (Core) Theory**	**Credits : 4**

Outcomes :-

1. Explain the basic concept of thermodynamics and its effects on the ionic strengths.
2. Determine thermodynamic efficiency of various energy related processes.
3. Estimate thermodynamic properties of substances in solid, gas and liquid states.
4. To explain concept of quantum chemistry, operators, oscillators and numerical.
5. Explain the phenomenon of surface chemistry, various theories of surface chemistry

Module	Course Content	Credits
Module I	**Chemical Thermodynamics :-** Nernst heat theorem, the third law of thermodynamics, Determination of absolute entropies of solids, liquids and gases. Partial molar properties : Partial molar free energy, chemical potential, partial molar volume and partial molar heat content and their significance, determination of these quantities, concept of fugacity and determination of fugacity .	01
Module II	**Quantum Chemistry:-** Rigid rotor, spherical coordinates Schrödinger wave equation in spherical coordinates, separation of the variables, the phi equation, wavefunction, quantum number, the theta equation, wave function, quantization of rotational energy, spherical harmonics. 2.2. Hydrogen atom, the two particle problem, separation of the energy as translational and potential, separation of variables, the R the θ * and the ϕ equations, solution of the requation, introduction of the four quantum numbers and their interdependence on the basis of the solutions of the three equations, total wave function, expression for the energy, probability density function, distances and energies in atomic units, radial and angular plots., points of maximum probability, expressions for the total wave function for 1s,2s, 2p and 3d orbitals of hydrogen. 2.3. Application of the Schrödinger equation to two electron system, limitations of the equation, need for the approximate solutions, methods of obtaining the approximate solution of the Schrödinger wave equation. 2.4. Hückel Molecular Orbitals theory for ethylene , 1,3-butadiene and benzene. (Derivation expected)	01
Module III	**Classical Thermodynamics :-** Collision theory, modified collision theory, weakness of the collision theory, Theory of absolute reaction rates, equilibrium hypothesis, Derivation of the rate equation, statistical mechanical derivation and thermodynamic formulation. Isotope effect on reaction rate. Primary salt effect, secondary salt effect. Dynamics of uni-molecular reactions,	01

	Lindmann and Hinshelwood theory Kinetics of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and NMR method. Reactions in solution: Reaction between ions, influence of solvent-double sphere model, single sphere model, influence of ionic strength, numericals.	
Module IV	**Surface Chemistry: -** Surface tension, capillary action, pressure difference across curved surface (Laplace equation) vapour pressure of droplets (Kelvin equation) Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro kinetic phenomenon), catalytic activity at surfaces, numericals. Colloidal electrolytes, Types of micelles in colloidal electrolytes, Micellization, Thermodynamics of micellization, Mechanism of Micellization, critical micellar concentration, Determinations of critical micellar concentration, Surface active agents, Classifications of surface active agents, Reverse micelles, Solubilization	01

Reference Books :

1. Chemical Kinetics - Laidler (McGraw-Hill)

2. Kinetic and Mechanism of Chemical Transformations - J. Rajaram and J.C. CURIACOSE (Macmillan India Ltd.)

3. Physical Chemistry - Atkins (Oxford)

4. Thermodynamics for Chemists - S. Glasstone (EWP, New Delhi)

5. Physical Chemistry - G. M. Barrow

6. Advanced Physical Chemistry - Gurdeep-Raj (Pelenum)

7. Micelles : Theoretical and Applied Aspects - V. Moroi (Plenum)

8. Text Book of Physical Chemistry - S.Glasstone (McMillan)

9. An Introduction to Electrochemistry - S. Glasstone (EWP, New Delhi)

10. Physical chemistry – Robert A .Alberty ., Robert J .Silbey 11. Statistical Thermodynamic – M. C. Gupta.

SEMISTER –I		
Code: 125311	**Course : Analytical Chemistry Major (Elective) Theory**	**Credits : 2**

Outcomes:-

1. To describe the basic concept of analytical chemistry. Qualitative and quantitative analysis.
2. To use/apply the basic statistical treatment of the analytical data for getting a correct result.
3. Describe the different separation techniques such as distillation, Solvent and Solid Phase extraction.
4. Explain the basic of chromatography.
5. To ensure safety in laboratories.
6. To identify different types of environmental pollutants and their global impact.
7. To correlate various methods for control of environmental pollution.

Module	Course Content	Credits
Module I	**Basic concepts of analytical chemistry: -** The role of analytical chemistry, qualitative and quantitative analysis, The analytical process, Validation of a method. Statistical treatment of analytical data: Introduction, types of errors, significant figures, precision and accuracy, methods of expressing accuracy, methods of expressing precision, the confidence limit, tests of significance- the F test, the student T test, rejection of results - the Q test. Statistics for small data sets, linear least squares, correlation coefficient, using spreadsheets for plotting calibration curves, slope, intercept and coefficient of determination, numericals.	01
Module II	**Chromatography Introduction:-** Basic principles and theory of chromatographic techniques, plate theory of chromatography, rate theory of chromatography, other factors in zone broadening, Development of the chromatogram - Frontal analysis, elution analysis displacement analysis, selection of chromatograph system, qualitative and quantitative analysis by chromatography.	
Module III	**Safety in Laboratories:-** Basic concepts of Safety in Laboratories, Personal Protection Equipment (PPE), OSHA, Toxic Hazard (TH) classifications, Hazardous Chemical Processes (including process calorimetry / thermal build up concepts).	01
Module IV	**Environmental Chemistry :-** Air pollution, water pollution, Impact of pollution in India, Pollution, pollution in India, Greenhouse effect, Acid rain, Ozone depletion and their consequences on environment, Major air pollution disasters, Pollution control methods and techniques, Sampling and analysis of air and water pollution	

Reference Books :

1. Fundamental of Analytical Chemistry 8th Edn . Skoog, West Hollar, Couch.
2. Analytical Chemistry 6th Edition., Gary D. Christian
3. Chemical Separations and Measurements, D.G. Peters, J.M. Hayes and G.M. Hiefti
4. Instrumental Method of Chemical Analysis, G.R. Chatwal&S.K.Anand.
5. A.K. De, Environmental Chemistry, New Age International Publication, 5thEdition.
6. . Mahajan, Environmental Pollution Control in Process Industries, Tata McGraw Hill Publishing Co. Ltd.
7. B.K.Sharma & H. Kaur, Environmental Pollution, Krishna Prakashan Media Pvt. Ltd.

SEMISTER –I		
Code: 125312	**Course : Nuclear Chemistry Major (Elective) Theory**	**Credits : 2**

Outcomes:-

1. To describe the basic concept of nuclear chemistry.
2. Identify and define various types of nuclear transmutation including fission, fusion and decay reactions.
3. Use of proper isotopic notation to write down and balance a nuclear reaction.
4. Understand the basics of nuclear chemistry applications: nuclear power, medical treatment, isotopic labelling, and carbon dating.
5. To understand the concept of nuclear fission & nuclear fusion

Module	Course Content	Credits
Module I	**Nuclear particles and its properties –** The fundamental particles, roll call of elementary particles, composition of the nucleus, theories of nuclear composition, nuclear properties, mass defect and binding energy, nuclear stability explained by different factors. Nuclear size and density,	01
Module II	**Nuclear models :-** The shell model and its salient features, periodicity in nuclear properties- magic numbers, forces of nuclear potential, energy level in nuclear potential well, the sequence of filling the orbital including models, nuclear configuration. The liquid drop model, and its details and The Fermi gas model	
Module III	**Nuclear structure:-** mass-energy relationship, nuclear binding energy, semi-empirical mass formula, nuclear stability rules, nuclear properties, mass size, spin and parity, nature of nuclear forces, liquid drop model, shell model, its evidence and advantages, comparison of the two models, calculations based on above.Energetics of nuclear reaction, cross reaction, comparison with chemical reactions, various types of nuclear reactions, photonuclear, spallation and thermonuclear reaction	01
Module IV	**Nuclear Reactions:-** Definition and Bethes notation, nuclear reaction energetic, nuclear reaction and threshold energy, characteristics of nuclear reactions, types of nuclear reactions, conservation in nuclear reactions, nuclear reactions cross section, cross section and reaction rate, the compound nucleus theory, general properties of compound nucleus, optical model, direct interaction model, specific nuclear reactions- photonuclear reactions, stripping and pickup reactions evaporation, spallation, fragmentation, direct nuclear reactions, thermonuclear reactions.	

Reference Books :

1. Elements of Nuclear Chemistry by H.J.Arnikar
2. Introduction to Nuclear Physics and Chemistry- B. G. Harvey (Prentice Hall of India)
3. Nuclear Chemistry and its application,- M. Hassinsky
4. Introduction to Nuclear Science- M. N. Sastry
5. Chemical applications of radioisotopes by H.J.M. Brown
6. A text book of Nuclear chemistry by C.V. Shekar Deminant publication & distribution, New Delhi.
7. Source of Atomic energy by s. Glasstance, D. Van Nostrand co. INC
8. Nuclear chemistry by M. G. Arora & M. Singh Anmol publication, New Delhi

SEMISTER –I		
Code: 125313	**Course : Polymer Chemistry Major (Elective) Theory**	**Credits : 2**

Outcomes:-

1. To achieve peer- recognition as a polymer chemist with understanding of principles, kinetic, and applications of different polymerization ways and techniques as well.
2. To provide the graduates with overall knowledge and skills on polymerization reactions.
3. To make the students competent to take up the challenging positions in polymer manufacturing industries, characterization laboratories, processing industries even some of them shall be able to focus as start up.
4. Summarize basics and various ways of polymerizations viz. chemistry, raw materials required, and their roles.

Module	Course Content	Credits
Module I	**Polymer Introduction:-** Monomer, oligomer and polymer, Average Molecular Weight, Molecular weight, Distribution & Poly dispersity Index, classification of polymers, structure of polymer. Types of polymerization.	01
Module II	**Classification of Polymers:-** Natural and synthetic polymers, Biopolymers, thermoplastic, thermosets, Elastomers, Fibers etc	
Module III	**Chemistry of Polymerization:-** Chain polymerization: free radical polymerization, ionic polymerization, co-ordination polymerization, Ziegler-Natta catalysts. Step Polymerization: polycondensation, polyaddition, ring opening, electro chemical polymerization, group, Transfer polymerization, Polymerization techniques	01
Module IV	**Polymerization Techniques:-** Mass Polymerization, Bulk Polymerization, Solution Polymerization, Emulsion Polymerization, Suspension Polymerization, Mechanisms with explanation. Characteristics, Relative advantages and disadvantages	

Reference Books :

1. V. T. Gowariker, N. V. Viswanathan, and J. Sreedar, Polymer Science
2. Polymer Science and Technology. By Premamoy Ghosh.
3. Polymers and Resins. By Brage Golding.
4. F. W. BillmeyerJr., Text Book of Polymer Science, Ed. Wiley-Interscience, 1984.

SEMISTER –I		
Code: 135311	**Course : Research Methodology Minor Theory**	**Credits : 4**

Outcomes:-

1. Discover the diverse facts of the research process, encircling the framing of impactful research questions, research design, data collection, analysis, writing, and presentation..
2. Gain an understanding of the research problem and the methods/techniques to be adopted.
3. Utilize statistical tools for analyzing data in the course of conducting research.
4. Cultivate proficiency in the analysis and presentation of qualitative and quantitative data.
5. Execute a quality research paper and patents in science and technology.

Module	Course Content	Credits
Module I	**Introduction to Research Methodology: -** Basic concept of Research, Definition, Types and Methods of Research, Concept of methodology Problem Identification & Formulation – Exploring the research area, conducting investigations, addressing measurement issues, formulating hypotheses, and understanding the qualities of a good hypothesis. This includes the concepts of Null & Alternative Hypothesis, and Hypothesis Testing with a focus on logic and importance, encompassing both parametric and non-parametric methods. Review of Literature: Investigating into the library domain, the module covers essential concepts of a scientific library, incorporating various resources such as journals, books, E-books, websites, and digital libraries. It also highlights the use of databases, including a specific mention of NCBI-Pub Med.	01
Module II	**Searching & Referencing :-** Explore effective literature search methods, utilizing search engines, and delve into the selection of research topics with a case study-based method. The module includes practical guidance on maintaining laboratory records, emphasizing case studies. It covers safety protocols in laboratories, ethical considerations, and the nuances of effective verbal and non-verbal communication. Additionally, the curriculum addresses field data collection techniques and safety measures in fieldwork. The module also introduces key research areas in chemistry	01
Module III	**Approaching the Research :-** Qualitative and Quantitative Research: This section explores the concepts of measurement, causality, generalization, and replication in both qualitative and quantitative research. It also addresses the integration of these two approaches. Journals: The module covers various aspects of journals, including indexing, H-index, I-10, ISSN, ISBN, abstracting journals, research journals, review journals, e-journals, and the impact factor of journals. It includes a focus on UGC Care Journals.	01

	Information Resources and Platforms: The module discusses reprints, the open-access initiative, and platforms such as INFLIBNET, INSDOC, Shodh Ganga, among others. Digital Research Tools and Platforms: This section covers the utilization of digital platforms like Google Scholar, Research Gate, LinkedIn, Orcid ID, Scopus (Q1 to Q4), Web of Science, and Boolean word searches. Indexing and Bibliography Management: The curriculum includes guidance on the preparation of index cards, covering author and subject indexes. It also introduces open-source bibliography management systems.	
Module IV	**Methods Of Scientific Writing & Research :-** Justification for scientific contributions, description of methods, conclusions, the need for illustration, style, publications of scientific work, writing ethics, avoiding plagiarism. Creating a research paper or thesis, crafting effective presentations, composing research proposals, and understanding the patenting process in the fields of science and technology are key components of this module. Students will develop skills in structuring and writing scholarly papers, honing the art of delivering compelling presentations, and formulating research proposals. Additionally, the module will delve into the intricacies of patenting within the realms of science and technology, providing a comprehensive understanding of intellectual property in research and innovation.	01

Reference Books :

1. Kothari– C.R. 2004. Research Methodology –Methods and Techniques, New Age International LTd. Publishers, New Delhi
2. P.S.G. Kumar (2004). Research methods and statistical techniques. B.R. publishing Academy, Udaipur.
3. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delh
4. The Statistical Analysis of Experimental Data' by, John Mandel, ISBN: 0486646661, ISBN13: 9780486646664

5.https://www.amazon.com/Research-Methods-Knowledge-Base-3rd/dp/1592602916

6. The craft of Research by by Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams

SEMISTER –I		
Code: 145311	**Course : Practical (Laboratory Course) Major (Core) Practical**	**Credits : 4**

Outcomes:-

1. To conduct separation and estimation of amount of metal ions in binary metal ion mixture.
2. To use/apply the basic statistical treatment of the analytical data for getting a correct result of Volhard's Method.
3. To conduct the experiment on various instrumental techniques.
4. To describe the principles behind the experiment performed in the laboratory.
5. To conduct chemical analyses by qualitative and quantitative analysis of metal complexes.
6. To conduct separation and estimation of amount of metal ions in binary metal ion mixture.
7. To Perform/demonstrate the techniques involved in organic binary mixture separation speciallysolid- liquid mixture.
8. To perform distillation techniques for purification of organic compounds.
9. To use/ apply the technique of separation , crystallization derivatization and function groupdetection.
10. To use the methods for the preparation of useful compounds using named reaction.
11. To interpret the experimental results obtained by refractometer, spectrophotomer, Ph meter,potentiometer.
12. To conduct the experiment on various instrumental techniques.
13. To describe the principles behind the experiment performed in the laboratory.

Module	Course Content	Credits
Module I	**Preparation and estimation of percentage metal ionpresent in a metal complexes :-** 1. Ti(C9H8NO) 2. 2H2O2. VO(acac)2 3. Cis-K[Cr(C2O4)2(H2O)2] 4. [Mn(acac)3] **Separation and estimation of amount of metal ionsfrom the following mixture solutions** 1. Copper- Nickel 2. Nickel- Zinc 3. Iron- Magnesium	01
Module II	**Qualitative Organic Analysis:-** Separation, purification and identification of binary (Solid-Solid) mixtures. The separation should be carried out usingChemical method. The two components are solid-solid mixtures. Student should submit the purified samples of the separated compounds and prepare a suitable derivative of the two compounds separated out.	01

	Single Stage Preparations: - i) p-nitro acetanilide from acetanilide. ii) Dibenzylidene acetone from Benzaldehyde The preparations should be carried out using (0.02 to 0.05 mole) of the starting material. ii) The yield, meltingpoint and TLC of the recrystalised product should be recorded.	
Module III	**Instrumentation:-** 1. Determination of strengths of halides in a mixture potentiometrically. 2. Determination of the strength of strong and weak acidin a given mixture conductometrically. 3. To study the effect of surfactants (sodium chloride) onsurface tension of given liquid. 4. To determine the radius of molecule by viscositymeasurements. **Non-Instrumentation.** 1. Determine the molecular refraction of methyl acetate,ethyl acetate, n-hexane and carbon tetrachloride and calculate the refraction of CH2, C, H and O atoms. 2. To study the effect of surfactants (sodium chloride) onsurface tension of given liquid. 3. To determine the radius of molecule by viscosity measurements.	01
Module IV	1. To determine the lead and tin content of a solder alloyby titration with EDTA. 2. To determine amount of Cu(II) present in the givensolution containing a mixture of Cu(II) and Fe(II). 3. To determine number of nitro groups in the givencompound using TiCl3. 4. To determine the breakthrough capacity of acation exchange resin.	01

Reference Books:

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by A. I. Vogels, 3rd Ed. ELBS(1964)

2. Vogel's textbook of quantitative chemical analysis, Sixth Ed. Mendham, Denny, Barnes, Thomas, Pearsoneducation

3. Standard methods of chemical analysis, F. J.Welcher

4. Standard Instrumental methods of Chemical Analysis, F. J.Welcher

5. W.W.Scott."Standard methods of Chemical Analysis", Vol. I, Van Nostrand Company, Inc.,1939. 6. E.B.Sandell and H.Onishi, "Spectrophotometric Determination of Traces of Metals", PartII,4th Ed., A Wiley Interscience Publication, NewYork,1978.

SEMESTER -II

SEMESTER –II		
Code: 215311	**Course : Inorganic Chemistry Major (Core) Theory**	**Credits : 4**

Outcomes:-

1. Describing the fundamental requirement for interpretation of electronic spectra of the metal compound for prediction of their properties.
2. Describing the studies of metal nitrosyls and their preparation, structures and properties.
3. Explaining the classification of metal clusters and compounds and the Chemistry of dioxygen, dinitrogen complexes and non-carbonyl metal clusters.
4. Explaining the properties of halogen compounds and noble gases.

Module	Course Content	Credits
Module I	**Spectroscopic term symbols:** - Inter-electronics repulsion, spin-orbit coupling, ground terms, determination of terms symbol of d1 to d5 Configuration/complexes, Energy ordering of terms, microstates. Racah parameter. Weak and stronger field approach. Correlation diagram of d^1 , d^2, d^8 and d^9 configuration in octahedral and tetrahedral environments, Non-crossing rule. Orgel diagram of d^1 to d^9 configuration in octahedral and tetrahedral environments, Tanabe Sugano diagram of d^2 and d^3 configurations.	01
Module II	**Organometallic Chemistry of Transition metals:-** 1. Eighteen and sixteen electron rule and electron counting with examples. 2. Preparation and properties of the following compounds (a) Alkyl and aryl derivatives of Pd and Pt complexes (b) Carbenes and carbynes of Cr, Mo and W (c) Alkene derivatives of Pd and Pt (d) Alkyne derivatives of Pd and Pt (e) Allyl derivatives of nickel (f) Sandwich compounds of Fe, Cr and Half Sandwich compounds of Cr,Mo. 3. Structure and bonding on the basis of VBT and MOT in the following organometallic compounds: Zeise's salt, bis(triphenylphosphine)diphenylacetylene platinum(0) [Pt(PPh3)2(HC≡CPh)2], diallylnickel(II), ferrocene and bis(arene)chromium(0), tricarbonyl (η2 -butadiene) iron(0)	01
Module III	**Halogen group & Noble gases:-** Halogen group:-Interhalogens, Pseudohalogen, synthesis, properties & applications, structure, oxyacids&oxoanions of Halogens Bonding. Noble gases:- Synthesis, properties, uses, structure & bonding with respect to VSEPR.	01
Module IV	**Metal nitrosyl compounds:-** Preparations and properties of Nitrosyl halides (NOX), Metal nitrosyl halides, compounds containing NO- group, Compounds containing NO+ groups, Preparation, structure and application of sodium Nitroprusside. EAN and Eighteen electron rules applied to nitrosyl compounds, Nitrosyl compounds of Cobalt, iron and Manganese. Significance of NO for the life of living animal.	01

Reference Books :

1. Inorganic Chemistry , J.E. Hubeey, E.A. Keitler, R.L.Keitler.
2. Concise Inorganic Chemistry - J.D.Lee.
3. Symmetry and Spectroscopy of Molecules - K. VeeraReddy
4. Advanced Inorganic Chemistry - Vol. I - Satyaprakash, Tuli, Basu andMadan.
5. Selected Topics in Inorganic Chemistry - W.U. Malik, G.D. Tuli& R.D.Madan.
6. Advanced Inorganic Chemistry Vol. I & Vol. II - Gurdeep andRaj.
7. Some aspect of Crystal Field theory- T. M. Dunn, D.S.Mcclure& R. G.Person

SEMESTER –II		
Code: 215312	**Course : Organic Chemistry Major (Core) Theory**	**Credits : 4**

Outcomes :

1. To describe various reactions involved in addition to C-C and C-O double bond
2. To Explain aromatic nucleophilic substitution reactions
3. To demonstrate/apply the concepts involved in oxidation & reduction reactions.
4. To describe the basic concepts in aromaticity.

Module	Course Content	Credits
Module I	**Aromatic Electrophilic and Nucleophilic Substitutions Electrophilic Substitutions:-** The arenium ion mechanism, orientation and reactivity, energy profile diagram. The ortho/para ratio, IPSO substitution, orientation in other ring systems, Recapitulation of halogenation, nitration, sulphonation and Fridel Craft's reaction, diazonium coupling. Nucleophilic Substitution: The SNAr, SN1, benzyne mechanism, Effect of substrate structure, leaving group and attacking nucleophile on reactivity.	01
Module II	**Addition to Carbon-Carbon multiple bonds:-** Mechanism and stereochemical aspect of addition reaction involving electrophile, nucleophile and free radicals. Regioselectivity and chemoselectivity, orientation and reactivity, Michael addition, Sharpless asymmetric epoxidation.	01
Module III	**Oxidation and Reduction:-** CrO3 (Jones reagent) PDC, PCC, KMnO4, MnO2, Swern, SeO2, Pb (OAc)4, Pd/C, OsO4, mCPBA, O3, NalO4, HIO4 R3 SiH, Bu3SnH, Boranes&Hydroboration reactions, MVP, H2/ catalyst, Wilkinson's catalyst, NaCNBH3, NH2NH2, DIBAL, etc	01
Module IV	**Aromaticity: -** 2.2.1. Structural, thermochemical, and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems. Delocalization and aromaticity. 2.2.2. Application of HMO theory to monocyclic conjugated systems. Frost-Musulin diagrams. Huckel's (4n+2) and 4n rules. 2.2.3. Aromatic and antiaromatic compounds up to 18 carbon atoms. Homoaromatic compounds. Aromaticity of all benzenoid systems, heterocycles, metallocenes, azulenes, annulenes, aromatic ions and Fullerene.	01

Reference Books :

1. Advanced Organic Chemistry, IV Edition: J.March
2. Advanced Organic Chemistry, Part-A and Part-B: F. A. Carey, & R. J.Sundburg.
3. A Guide Book to Mechanism in Organic Chemistry: PeterSykes.
4. Organic Chemistry: Clayden andGreeves
5. March'sAdvancedOrganicChemistry:Reactions,MechanismsandStructure,MichaelB.Smith, Jerry March, Wiley
6. Advanced Organic Chemistry: Reactions and mechanism, L.G. Wade, Jr., Maya Shankar Singh, PearsonEducation.
7. Organic Synthesis, Jagdamba Singh, L.D.S. Yadav, PragatiPrakashan.

SEMESTER –II		
Code: 215313	**Course : Physical Chemistry Major (Core) Theory**	**Credits : 4**

Outcomes: -

1. Explain the concept of activation energy and its effects on the rates of chemicalreactions.
2. Apply the tools to derive the rate law and itsmechanism
3. To explain the influence of different parameters on the rate ofreactions
4. To explain the concept of quantum chemistry, operators, oscillators andnumerical.
5. Apply the basic principles of the major spectroscopes, including Raman, ESR, Mossbauer,NMR.

Module	Course Content	Credits
Module I	**Quantum Chemistry:-** The Schrodinger equation, particle in a one-dimensional box, Eigen values and Eigen functions, operators, properties of quantum mechanical operators, Hermitian, Linear, Ladder, Hamiltonian and angular momentum operators. Particle in three dimensional box, harmonic oscillator, rigid rotator and numericals.	01
Module II	**Chemical Kinetics and Molecular Reaction Dynamics:-** . Elementary Reactions in Solution:- Solvent Effects on reaction rates, Reactions between ions- influence of solvent Dielectric constant, the influence of ionic strength, Linear free energy relationships Enzyme action . Kinetics of reactions catalyzed by enzymes -Michaelis-Menten analysis, Lineweaver-Burk and EadieAnalyses. . Inhibition of Enzyme action: Competitive, Noncompetitive and Uncompetitive Inhibition. Effect of pH, Enzyme activation by metal ions, Regulatoryenzymes. . Kinetics of reactions in the Solid State:- Factors affecting reactions in solids Rate laws for reactions in solid: The parabolic rate law, The first order rate Law, the contracting sphere rate law, Contracting arearate law, some examples of kinetic studies.	01
Module III	**Quantum Chemistry:-** Term symbols and selection rules, spin-orbital coupling, the variation theorem, nondegenerate perturbation theory and applications. Huckel molecular orbital theory of conjugated systems, application to ethylene, butadiene, cyclopropyl radical, cyclobutadiene and benzene, numericals.	01
Module IV	**Molecular Spectroscopy:-** 1. Raman Spectroscopy:- Introduction, Rotational Raman spectra, Vibrational Raman Spectra, the polarization of light and Raman effect, structure elucidation from combined Raman and IR spectroscopy, applications in structureelucidation. 2. Electronic spectroscopy of molecules:- Born – Oppenheimer approximation, electronic spectra of diatomic molecules, vibrational coarse structure, rotational fine structure dissociation energy and dissociation products, electronic structure of diatomic molecules, molecular photoelectron spectroscopy,application. 3. ESR and Mossbauer spectroscopyapplications.	01

	4. Principles of NMR: - Chemical applications of PMR in structure elucidation.	

Reference Books :

1. Quantum Chemistry: Ira N.Levine
2. Quantum Chemistry: R.K.Prasad
3. Quantum Chemistry: B.K.Sen
4. Introduction to Molecular Photo-chemistry: C.H.J.Wells
5. Atkin's Physical Chemistry: PeterAtkins
6. Physical Chemistry: G.K.Vemulapalli.
7. Fundamentals of molecular spectroscopy: C.N. Banwell and E.Mc. Cash (Fourthedition).
8. K.J. Laidler and J.H. Meiser, Physical Chemistry, 2nd Ed., CBS Publishers and Distributors, New Delhi,1999.
9. Principles of Chemical Kinetics, 2nd Ed., James E. House, ELSEVIER,2007.

SEMESTER –II		
Code: 225311	**Course : Analytical Chemistry Major (Elective) Theory**	**Credits : 2**

Outcomes: -

1. Describe and understand the basic profile of electromagnetic radiations, scientific notations for absorption, emission, transmission, reflection, dispersion, polarization and Classify electromagnetic spectrum ion of spectra.
2. Describe the basic concept of microwave spectroscopy and classify molecules based on structural parameters like the moment of inertia and inter molecular distances
3. To use/apply the basic statistical treatment of the analytical data for getting a correct result
4. Participants will be able to work more efficiently with knowledge of basic principles.
5. Able to collect data, literature survey for a research project.

Module	Course Content	Credits
Module I	**General introduction of spectral methods of analysis:-** Characterization of electromagnetic radiations, Regions of the spectrum, Interaction of radiations with matter - absorption, emission, transmission, reflection, dispersion, polarization and representation of spectra, basic elements of practical spectroscopy, resolving power, signal to noise ratio. Uncertainty relation and natural line width, natural line broadening, the intensity of spectral lines, energy levels, selection rules, components of the spectrometer and their functions. Microwave spectroscopy: Rotation of molecules, rotational spectra, diatomic molecules - rigid diatomic molecules, intensities of spectral lines, the effect of the isotopic substitution, non-rigid rotator, the spectrum of a non-rigid rotator, polyatomic molecules, technique and instrumentation in outline, applications, numerical problems.	01
Module II	**Laboratory work:-** . Fundamental Laboratory Techniques:- Basic principles, Health and safety, Working with liquids, Basic laboratory procedures I & II, Principles of solution chemistry, pH and buffersolutions. . The investigative approach:- Making and recording measurements, SI units (International System of Units) and their use, Scientific method and design of experiments, Project work. Collection of data (primary, secondary), literature survey & review. . Analysis and presentation of data: Using graphs, Presenting data in tables, Hints for solving numerical problems, Descriptive statistics, Choosing and using statistical tests, drawing chemical structures, Chemometrics, Computationalchemistry. 4. Statistical Packages for Social Science (SPSS)Workshop.	
Module III	**Data Analysis:-** . Analysis and presentation of data: Using graphs, Presenting data in tables, Hints for solving numerical problems, Descriptive statistics, Choosing and using statistical tests, drawing chemical structures, Chemometrics, Computationalchemistry. 2. Statistical Packages for Social Science (SPSS)Workshop.	01

Module IV	**Spectroscopy:-** Vibrational spectroscopy Review of the linear harmonic oscillator, the vibrating diatomic molecule, the simple harmonic oscillator, the anharmonic oscillator, the diatomic vibrating rotator, the vibration-rotation spectrum of carbon monoxide, breakdown of the Born-Oppenheimur approximation, the vibration of polyatomic molecules, overtones and combination frequencies, the influence of rotation on the spectra of polyatomic molecules, the influence of nuclear spin, symmetric top molecules, analysis by Infra-red technique - Group frequencies, the outline of technique and instrumentation. Raman spectroscopy: Classical and quantum of the theory of Raman effect, pure rotational, vibrational and vibrational-rotational Raman spectra, rule of mutual exclusion, overtone and combination vibrations, Rotational fine structure, the outline of technique and instrumentation, applications.	

Reference Books :

1. Instrumental Methods of Chem. Analy. Chatwal andAnand.
2. Instrumental Methods of Chemical Analysis - Willard, Merritt, Dean&Seatle
3. Instrumental Methods of Chemical Analysis - Chatwal,Anand
4. Instrumental Methods of Chemical Analysis -R.D.Braun
5. Fundamentals of Molecular Spectroscopy:Banwell.
6. Atomic and Molecular Structure:ManasChanda
7. Spectroscopic Methods in Organic Chemistry: D.H. Williams andI.Fleming.
8. Organic Spectroscopy: William Kemp (3rdEdition).
9. Inorganic Chemistry - Atkins andShriver.
10. Principles of Instrumental Analysis - Skoog, Holler and Nieman, 5thEdition.
11. Undergraduate Instrumental Analysis, 6th Edition, J W Robinson, MarcelDekker.
12. Quality Control and Total Quality Management - P.L. Jain-Tata McGraw-Hill (2006) Total Quality Management - Bester field - PearsonEducation.
13. Industrial Hygiene and Chemical Safety, M HFulekar.
14. 3000 solved problems in chemistry, Schaums Solved problem series, David E. Goldberg, McGraw Hill InternationalEditions.

SEMISTER –II		
Code: 225312	**Course : Nuclear Chemistry Major (Elective) Theory**	**Credits : 2**

Outcomes:-

6. To describe the basic concept of nuclear chemistry.
7. Identify and define various types of nuclear transmutation including fission, fusion and decay reactions.
8. Use of proper isotopic notation to write down and balance a nuclear reaction.
9. Understand the basics of nuclear chemistry applications: nuclear power, medical treatment, isotopic labelling, and carbon dating.
10. To understand the concept of nuclear fission & nuclear fusion

Module	Course Content	Credits
Module I	**Radioactivity:-** Types of radioactive decay, general characteristics of radioactive decay, decay kinetics,general expression for the activity of a daughter nuclide, Geiger- Nuttalis law, α-decay: A problem in classical physics, Internal conversion and the Auger effect.	01
Module II	**Elements of Radiation** Chemistry: Interaction of radiation with matter, interaction of γ radiation with matter, units for measuring radiation absorption, Radiation dosimetry, Radiolysis of water, free radicals in water radiolysis, Radiolysis of some aqueous solutions.	
Module III	**Radiation chemistry and its applications :-** Introduction of radiation with matter, primary effects due to charged particle/radiation, Linear energy transfer(LET), Bethes equation for LET, Bremsstrahulung, the cerenkov radians, interactions of electron with matter, interaction of neutrons with matter, interaction of heavy charged particles with matter, interaction of rays with matter, units for measuring radiation absorption, absorption in water B. Typical reactions involved in the preparations of isotopes: the scillard-chalmers reactions, radiochemical principles in the use of tracers, typical application of radioisotopes as tracers- chemical investigation, physio-chemical research, analytical applications, agricultural applications, industrial applications, use of nuclear radiations, radioisotope as a source of electricity	01
Module IV	**Nuclear fission and fusion:-** The discovery of nuclear fission, the process of nuclear fission, fission fragments and their mass distribution, charge distribution, Ionic charge of fission fragments, fission energy, fission cross-section and threshold, fission neutrons, theory of nuclear fission, Neutron evaporation and spallation, heavy water- manufacturing and use in reactors. accelerators, nuclear fusion. Production of isotopes by nuclear reactions	

Reference Books :

1. Elements of Nuclear Chemistry by H.J.Arnikar
2. Introduction to Nuclear Physics and Chemistry- B. G. Harvey (Prentice Hall of India)
3. Nuclear Chemistry and its application,- M. Hassinsky
4. Introduction to Nuclear Science- M. N. Sastry
5. Chemical applications of radioisotopes by H.J.M. Brown
6. Nuclear chemistry by M. G. Arora & M. Singh Anmol publication, New Delhi
7. Elements of nuclear chemistry by A. K. Srivastav, P. C. Jain, S. Chand & Co.
8. Radiochemistry & nuclear chemistry, 3rd edn G. chappin, Butterwerth-Heinemann

SEMISTER –II		
Code: 225313	**Course : Polymer Chemistry Major (Elective) Theory**	**Credits : 2**

Outcomes:-

1. To achieve peer- recognition as a polymer chemist with understanding of principles, kinetic, and applications of different polymerization ways and techniques as well.
2. To provide the graduates with overall knowledge and skills on polymerization reactions.
3. To make the students competent to take up the challenging positions in polymer manufacturing industries, characterization laboratories, processing industries even some of them shall be able to focus as start up.
4. Summarize basics and various ways of polymerizations viz. chemistry, raw materials required, and their roles.
5. To understand uses of macromolecules
6. To understand origin & application of natural rubber

Module	Course Content	Credits
Module I	**Kinetics of Polymerization:-** Free radical chain polymerization, Anionic polymerization, Cationic polymerization, Copolymerization, Free radical copolymerization, Ionic copolymerization, Copolycondensation	01
Module II	**Structure Property Relationship in Polymers:-** Structure of polymers, amorphous, semicrystalline and crystalline states in polymers, glass transition, melting and crystallization temperature. Effect of structure on the chemical, mechanical, electrical and optical properties of polymers.	
Module III	**Macromolecules :-** Introduction, Formation of synthetic high polymers classification, Polymerization reactions: Chain and Step. Average molecular weight, Number average weight, Methods of determination of molar masses of polymers; Viscosity, Osmometry, Molar mass of charged macromolecules, Donnan membrane equilibrium, Ultracentrifugation, light scattering, Diffusion.	01
Module IV	**Natural Rubber :-** Origin–Natural Rubber Latex, tapping, processing, properties and applications – Conversion of Latex into dry rubber – Properties of dry rubber – Classification based on technical specifications – Modifications of Natural Rubber	

Reference Books :

1. V. T. Gowariker, N. V. Viswanathan, and J. Sreedar, Polymer Science
2. Polymer Science and Technology. By Premamoy Ghosh.
3. Polymers and Resins. By Brage Golding.
4. F. W. BillmeyerJr., Text Book of Polymer Science, Ed. Wiley-Interscience, 1984.
5. B. Kothandaraman, Rubber Materials, Ane Books, 2008.

SEMISTER –II		
Code: 245311	**Course : Practical (Laboratory Course) Major (Core) Practical**	**Credits : 4**

Outcomes: -

1. To conduct chemical analyses by qualitative and quantitative analysis of metal complexes.
2. To Perform/demonstrate the techniques involved in organic binary mixture separation specially solid-liquid mixture.
3. To interpret the experimental results obtained by the potentiometer, pH meter, conductometer.
4. To conduct the experiment on various instrumental techniques.
5. To describe the principles behind the experiment performed in the laboratory.
6. To develop skills in chromatographic techniques for analysis.

Module	Course Content	Credits
Module I	**Semi micro qualitative inorganic analysis:-** Identification of three acidic and three basic radicals including one rare earth from the given mixture. **Separation and estimation of the amount of metal ions from the following mixture solutions:-** 1. Copper-Barium 2. Iron–Aluminum Copper-Iron	01
Module II	**Qualitative Organic Analysis:-**Separation, purification, and identification of binary (Solid-Liquid) mixtures. The separation should be carried out using the Chemical method. The two components are solid-liquid mixtures. The student should submit the purified samples of the separated compounds and prepare a suitable derivative of the two compounds separated out.	01
Module III	**Instrumentation:-** . Determination of strengths of halides in a mixture potentiometrically. . Determination of the strength of strong and weak acids in a given mixture conductometrically. . Determination of solubility and solubility product of sparingly soluble saltBaSO4. . Determine the pK1 and pK2 value of phosphoric acid by pHmetry . Determine the indicator constant of given indicator by colorimetric measurements	01
Module IV	**Chromatography:**- Ion- exchange chromatography, Thin layer chromatography. **Colorimetric Analysis of elements:-** Estimation of metal ions, pk value of metal ions, Estimation of the mixture of metal ions	01

Reference Books :

1. A Text book of Micro and Semi micro Qualitative Inorganic Analysis, IV edn, A. I.Vogel
2. A Text book of Quantitative Inorganic Analysis; A. I.Vogel
3. Practical Inorganic Chemistry- Pass Geoffrey and Haydn Sutcliffe.
4. Advanced Practical Inorganic Chemistry- Gurdeep Raj.
5. Vogel's Qualitative InorganicAnalysis,VIIEdn.Orient LongmanLtd.D.Svehla.
6. Systematic experimental physical chemistry – T. K. Chondhekar & S.W.Rajbhoj
7. Experiments in chemistry – D.V.Jahagirdar