DEPARTMENT OF CHEMISTRY

NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

190006 (J&K) India

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M.Sc. Chemistry

Revised Curriculum and Syllabi
(w.e.f. Autumn-2023)

REVISED CURRICULUM FOR POST-GRADUATE PROGRAM

LEADING TO MASTER OF SCIENCE (MSc) DEGREE IN CHEMISTRY

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(2023)

Revised Scheme MSc Chemistry (Two-Year Full-Time Programme)-Autumn-2023

FIRST YEAR													
I Semester							**II Semester**						
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**S. No.**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
	Core Courses							**Core Courses**					
1.	MSCYT- 101	Structure, Reactivity and Stereochemistry of Organic Molecules	2	1	0	3	1.	MSCYT- 201	Organic Reaction Mechanisms	2	1	0	3
2.	MSCYT- 102	General Inorganic Chemistry	2	1	0	3	2.	MSCYT- 202	Bio-Inorganic & Nuclear Chemistry	2	1	0	3
3.	MSCYT- 103	Quantum Chemistry	2	1	0	3	3.	MSCYT- 203	Advanced Electrochemistry & Chemical Kinetics	2	1	0	3
4.	MSCYT- 104	Instrumental Methods of Chemical Analysis	2	1	0	3	4.	MSCYT- 204	Chromatographic Techniques	2	1	0	3
	Electives (Students have to choose any two out of four electives)							**Electives (Students have to choose any two out of four electives)**					
1.	MSCYE- 105	Supramolecular Chemistry	2	0	0	2	1.	MSCYE- 205	Bio-molecules	2	0	0	2
2.	MSCYE- 106	Environmental Chemistry	2	0	0	2	2.	MSCYE- 206	Group Theory	2	0	0	2
3.	MSCYE- 107	Tribochemistry of Lubricating Materials	2	0	0	2	3.	MSCYE- 207	Energy Conversion and Storage Systems	2	0	0	2
4.	MSCYE- 108	Fundamentals of Analytical Techniques	2	0	0	2	4.	MSCYE- 208	Spectrochemical Methods	2	0	0	2
	Lab Courses							**Lab Courses**					
1.	MSCYL-109	Organic Practical-I	0	0	3	1.5	9.	MSCYL-209	Organic Practical-II	0	0	3	1.5
2.	MSCYL-110	Inorganic Practical-I	0	0	3	1.5	10.	MSCYL-210	Inorganic Practical-II	0	0	3	1.5
3.	MSCYL-111	Physical Practical-I	0	0	3	1.5	11.	MSCYL-211	Physical Practical-II	0	0	3	1.5
	Total Hrs./Credits		**25**			**20.5**		**Total Hrs./Credits**		**25**			**20.5**

SECOND YEAR													
III Semester							**IV Semester**						
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**S. No.**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
	Core Courses							**Project**					
1.	MSCYT- 301	Organic Spectroscopy and Modern Organic Synthesis	2	1	0	3	1.	MSCYS- 401	Project Seminar	0	0	0	1
2.	MSCYT- 302	Organometallic Chemistry	2	1	0	3	2.	MSCYP-402	Project Work/ Dissertation	0	0	0	14
3.	MSCYT- 303	Solid State Chemistry and Thermodynamics	2	1	0	3							
4.	MSCYT- 304	Advanced Instrumentation Techniques	2	1	0	3							
	Electives (Students have to choose any two out of four electives)												**15**
1.	MSCYE- 305	Applied Organic Chemistry	2	0	0	2		***Curriculum Summary***					
2.	MSCYE- 306	Nanotechnology	2	0	0	2	1.		***Category***				***C***
3.	MSCYE- 307	Organic Flexible Electronic Materials	2	0	0	2	2.		*Core Courses*				*36*
4.	MSCYE- 308	Polymer Chemistry	2	0	0	2	3.		*Elective Courses*				*12*
	Lab Courses						4.		*Laboratory*				*12*
1.	MSCYL-309	Analytical Chemistry Lab	0	0	3	1.5	5.		*Project*				14
2.	MSCYL-310	Computer Methods in Chemistry Lab	0	0	3	1.5	6.		*Project Seminar*				*1*
	Total Hrs./Credits		**22**			**19**		**Total Hrs./Credits**					**75**

CREDITS POINTS SUMMARY					
Semesters	Sem-I	Sem-II	Sem-III	Sem-IV	Overall
Credits	20.5	20.5	19	15	75

List of Electives

S. No.	Course Code	Course of the Study	L	T	P	C
1.	MSCYE- 105	Supramolecular Chemistry	2	0	0	2
2.	MSCYE- 106	Environmental Chemistry	2	0	0	2
3.	MSCYE- 107	Tribochemistry of Lubricating Materials	2	0	0	2
4.	MSCYE- 108	Fundamentals of Analytical Techniques	2	0	0	2
5.	MSCYE- 205	Bio-molecules	2	0	0	2
6.	MSCYE- 206	Group Theory	2	0	0	2
7.	MSCYE- 207	Energy Conversion and Storage Systems	2	0	0	2
8.	MSCYE- 208	Spectrochemical Methods	2	0	0	2
9.	MSCYE- 305	Applied Organic Chemistry	2	0	0	2
10.	MSCYE- 306	Nanotechnology	2	0	0	2
11.	MSCYE- 307	Organic Flexible Electronic Materials	2	0	0	2
12.	MSCYE- 308	Polymer Chemistry	2	0	0	2

Students have to opt any two of the electives in each semester as per the MSc Scheme-2023.

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Subject: Structure, Reactivity and Stereochemistry of Organic Molecules (Code-MSCYT-101)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 3**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	1	0
Course Instructor (s)	Prof. J. A. Banday				

Course Objective	The course has been designed to enable the students to learn the structure, reactivity and stereochemistry of organic molecules.
Course Outcomes (COs)	
On successful completion of the course, the student will be able to about:	
CO1	Electronic effects and concept of aromaticity.
CO2	Involvement of reactive intermediates and understand their structure and reactivity through various organic reactions.
CO3	Stereochemistry of organic compounds at an advanced level.
CO4	Substitution & elimination reactions in aliphatics.
Module-I	**Nature of Bonding in Organic Molecules [11 L]** Electron Displacement effects: Inductive effect, Resonance effect, Hyperconjugation, Rules for writing resonance structures. Tautomerism: Different types including valence tautomerism. Aromaticity: Concept of aromaticity-Huckel rule, Classification of aromatic compounds-homocylcic and heterocyclic, Homo-aromaticity and Anti aromaticity. Annulenes: Aromaticity of hetero annulenes. Aromaticity in fused ring systems. Aromaticity of ferrocene and azulene. Molecular orbital diagram of annulenes.
Module-II	**Bond Cleavage & Reaction Intermediates [10 L]** Homolytic and heterolytic bond cleavage. Reactive Intermediates: Generation, Structure, fate and stability of Carbocations (Classical and Non- Classical), Carbanions, Free radicals, Carbenes, Nitrenes, Arynes and Radical ions.
Module-III	**Stereochemistry [11 L]** Conformations: Origin of conformational energy. Angle and Pitzer strain. Conformational analysis of cycloalkanes. Effect of conformation on reactivity in acyclic and cyclic systems. Conformation of sugars & anomeric effect.

	Conformation of cyclohexane, cyclohexanones and bicycloheptane – a bridged system. Chirality: Introduction, Chirality due to chiral centre. Molecules with more than one Chiral centers, Threo and erythro isomers. Configuration-Relative (D, L) and absolute configuration (R, S) configurations. Optical activity due to chiral axis, chiral plane and helicity. Enantiotopic and diastereotopic atoms, groups and faces.
Module-IV	**Substitution & Elimination Reactions in Aliphatic compounds [10 L]** Nucleophilic Substitutions: The SN2, SN1, mixed SN1 and SN2 and SET mechanisms. The neighboring group mechanism, neighboring group participation by π and σ bonds, anchimeric assistance. The SNi mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, regioselectivity. Elimination reactions: Factors affecting elimination reactions, Mechanism of E1, E2, E1cB and E2C reactions. Competition between substitution and elimination reactions. Stereochemistry and regioselectivity of E2 eliminations, Elimination in cyclic systems and vinyl halides. Mechanism and orientation in pyrolytic eliminations, Shapiro reaction.

Books Recommended:

1. Smith, M. B., March J., Advanced Organic Chemistry, 7th Ed., 2016. Wiley.
2. Carey F. A., Giuliano R. M., Organic Chemistry, 8th Ed. 2012, McGraw Hill.
3. Kalsi P. S., Stereochemistry of Organic Compounds, 7th Ed., 2012, New Age Inter.
4. Solomons, T.W.G., Organic Chemistry, 11th Ed., 2015, Wiley.
5. Carey F. A., Sundberg, R. J., Advanced Organic Chemistry Part A: Structure and Mechanisms, 5th Edition, 2007, Springer.
6. Carey, F. A. and Sundberg, R. J., Advanced Organic Chemistry Part B: Reactions and Synthesis, 5th Edition, 2007, Springer.

DEPARTMENT OF CHEMISTRY
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Subject: General Inorganic Chemistry (Code-MSCYT-102)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 3**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	1	0
Course Instructor (s)	Prof. Hamida Chisti				

Course Objective	The course aims at understanding the chemistry of main group, transition and inner transition elements and the detailed interception of bonding concepts, reaction mechanism in coordination compounds.
Course Outcomes (COs)	
On successful completion of the course, the student will be able to about:	
CO1	Structure and reactivity of main group compounds.
CO2	Chemistry of Transition and Inner-transition elements.
CO3	Theories, bonding and structure of coordination compounds.
CO4	Reaction mechanism in coordination complexes.
Module-I	**Chemistry of Main Group Elements [10 L]** General introduction to Chemical Periodicity, Structure and bonding (VBT and MOT) in homo and hetero nuclear molecules -H_2, O_2, N_2, F_2, and NO, CO, HCl. Molecular shape and the VSEPR model: Effect of Lone pairs, Effect of electronegativity, isoelectronic principle (e.g., NH_3, BF_3, $[BF_4]^-$, PCl_5, SF_4, I_3^-, SF_6, IF_7. Synthesis, Properties, Structure and Bonding of: Nitrogen, Phosphorous, Sulfur, Pseudohalogen, Interhalogen and Xenon Compounds, Borazines, Phosphazenes, Sulfur-Nitrogen compounds, Silicones, bonding and reactions in higher boranes,Wades rules and STYX numbers, Carboranes, Metallocarboranes. Preparation, structure.
Module-II	**Chemistry of Transition & Inner Transition Elements [10 L]** Transition elements: Introduction, Oxidation state, Size, Chemical properties and Complexes of Group 3- Group12 elements. Inner transition elements: Introduction, Characteristics, Extraction, Lanthanide Contraction, energetics, binary compounds, coordination chemistry, General Principles, Coordination numbers in lanthanide and actinide complexes, electronic and magnetic properties, Electronic Spectra, Luminescence Spectra.
Module-III	**Coordination Chemistry-I [11 L]** Theories of electronic Structure: Terminology and Historical background of VBT and CFT. Ligand Field Theory: Molecular Orbitals for octahedral complexes,

	Orbital splitting and electron spin, ligand Field stabilization energy, pi bonding, square planer complexes, tetrahedral complexes. Angular overlap: Sigma-donor interactions, pi acceptor interactions, pi donor interactions, types of ligands and the spectrochemical series. The Jahn Teller effect: octahedral and tetrahedral Complexes. Absorption of light: Beer Lamberts Absorption law. Quantum numbers of multi electron atoms: Spin-Orbit Coupling, term Symbols. Electronic Spectra of coordination compounds: selection rules, Correlation diagrams (Orgel Diagrams), Tanabe Sugano Diagrams.
Module-IV	**Coordination Chemistry-II** **[11 L]** Substitution reactions: Inert and Labile Compounds, Mechanisms of substitution. Kinetic consequences of reaction pathways: Dissociation, interchange and Association. Experimental evidence in octahedral substitution: Dissociation, Linear free energy relationships, associative mechanisms, the conjugate base mechanism, the kinetic chelate effect. Stereochemistry of reactions: substitution in trans complexes, substitution in Cis-complexes, Isomerization of chelate rings. Substitution reactions in square planar complexes: Kinetics and stereochemistry of square planner substitutions, Evidence for Associative reactions. Trans effect: Explanations of trans effect. Oxidation reduction reactions: inner and outer sphere reactions, conditions for high and low oxidation numbers.

Recommended Books:

1. Huheey J. E., Inorganic Chemistry, 4th Edn., 2008, Pearson.
2. Miessler G. L., Tarr D.A., Inorganic Chemistry, 3rd Edn., 2008, Pearson.
3. Cotton F. A., Wilkinson G., Murillo C. A., Bochmann M., Advanced Inorganic Chemistry, 6th Edn., 1999, Wiley.
4. Weller and Armstrong, Inorganic Chemistry, 6th Edn., 2015, Oxford.
5. Lee J. D., Concise Inorganic Chemistry, 5th Edn., 1999, Wiley,
6. Atkins and Shriver, Inorganic Chemistry, 5th Edn., 2009.

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Subject: Quantum Chemistry (Code-MSCYT-103)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 3**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	1	0
Course Instructor (s)	Dr. Shrikant Shivaji Maktedar				

Course Objective	The course has been designed to enable the students to learn about the quantum chemistry.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Quantum mechanics.
CO2	Electronic structure of atoms.
CO3	Quantum chemistry.
CO4	Molecular orbital theory of conjugates systems.
Module-I	**Quantum Chemistry-I** **[12 L]** Need for quantum mechanics, Operator concept, Quantum mechanical operators (Cartesian and spherical polar co-ordinate systems), Eigen value equations and their significance. Properties of quantum mechanical operators, Postulates and theorems of quantum mechanics. Review of particle in a box problem, extension to two and three dimensions, applications. Solution of harmonic oscillator and the rigid rotator problems. Quantum mechanical tunneling.
Module-II	**Quantum Chemistry-II** **[10 L]** Born-Oppenheimer approximation, Solution of the Hydrogen-like atom problem- radial and angular wave functions. Angular momentum and electronic structure of atom, General theory of angular momentum, Eigen functions and eigenvalues of angular momentum operators, Ladder operators, Spin angular momentum, Anti-symmetry, and Pauli's principle. Atomic term symbols, Term symbol of pn and dn configurations, Spin-Orbit coupling.
Module-III	**Quantum Chemistry-III** **[10 L]** 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.

Module-IV	**Quantum Chemistry-IV** **[10 L]** Term Symbols and Selection Rules, Spin-Orbital Coupling, The Variation Theorem, Non-Degenerate Perturbation Theory and Applications. Huckel Molecular Orbital Theory of Conjugated Systems, Application to Ethylene, Butadiene, Cyclopropenyl Radical, Cyclobutadiene and Benzene, Numericals.

Recommended Books:

1. McQuarie D. A., Quantum Chemistry, Student Edn., 2018, Viva Books Pvt Ltd.
2. Prasad R. K., Quantum Chemistry, 4th Edn., 2010, New Age Publishers.
3. Levine I. N., Quantum Chemistry, 7th Edn. 2013., Prentice Hall.
4. Atkins P. W., Physical Chemistry, 8th Edn. 2006, Oxford University Press.

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Subject: Instrumental Methods of Chemical Analysis (Code-MSCYT-104)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 3**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	1	0
Course Instructor	Dr. Mohammad Aslam				

Course Objective	The course has been designed to enable the students to learn the analysis of experimental data and learn various analytical techniques used which would be applied in all areas of research and various industries.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Data handling and statistical treatment of data.
CO2	Thermal methods like TGA, DTA, DSC and their applications to material science.
CO3	Electroanalytical techniques like voltammetry and polarography.
CO4	Atomic spectroscopy techniques like AAS, AES, AFS etc.
Module-I	**Data Analysis** **[11 L]** Errors, classification of errors and their minimization; absolute, relative, determinate and indeterminate errors, statistical treatment of random errors, accuracy and precision, methods of expressing accuracy and precision, significant figures, computation rules for significant figures, The Gaussian distribution, mean and standard deviation, confidence intervals, statistical tests of data (the F test, the t test, Q test, ANOVA).
Module-II	**Thermal Methods** **[10 L]** Introduction to thermal methods, classification of thermal methods, Thermogravimetric analysis, apparatus, methodology, applications; derivative thermogravimetry, instrumentation, methodology, applications; differential thermal analysis, apparatus, methodology, applications; differential scanning calorimetry; instrumentation, methodology and applications. Comparative study of TGA, DTA and DSC. Interpretation of various thermograms of important compounds e.g., silver nitrate, calcium oxalate monohydrate, magnesium oxalate dihydrate. Thermogravimetric analysis of dolomite and calcite samples and their purity analysis. Applications of thermal methods in material science.

Module-III	**Electroanalytical Methods [11 L]** Introduction to electroanalytical methods, principle of voltammetry, excitation signals in voltammetry, types of voltammetry, voltammetric instrumentation, working, reference and auxiliary electrodes, voltammogram, hydrodynamic voltammetry and their applications, cyclic voltammetry, anodic and cathodic peak currents, anodic and cathodic peak potential, Randles–Sevcik equation, cyclic voltammograms of $K_3[Fe(CN)_6]$, applications of voltammetry. Polarography; principle of polarography, instrumentation, dropping mercury electrode (DME), residual, diffusion and limiting currents, half-wave potential, Ilkovic equation, applications of polarography.
Module-IV	**Atomic Spectroscopy [10 L]** Atomic Absorption Spectroscopy (AAS): Origins of atomic spectra, production of atoms and ions, Principles, instrumentation and applications. Atomic Emission Spectrometry (AES): Principles, Instrumentation, Analytical Measurements and Applications. Atomic fluorescence spectrometry (AFS): principle, instrumentations, working and applications. Inductively Coupled Plasma–mass Spectrometry (ICP–MS): Principles, Instrumentation and Applications.

Recommended Books:

1. Christian G. D., Dasgupta P. K., Schug K. A., Analytical Chemistry, (2020), Willey Publisher.
2. Skoog D., Holler F., Crouch S., Principles of Instrumental Analysis, 7th Edition 2017, Brooks/Cole Publishers.
3. Willard, Merritt, Dean, Settle, Instrumental Methods of Analysis, 7th Edition, 1986, CBS Publisher.
4. Harvey D., Modern Analytical Chemistry, 2000, McGraw Hill Education, New York.
5. Skoog D. A., Donald M. W., Holler F. J., Crouch S.R., Fundamentals of Analytical Chemistry, 9th Edition, 2014, Brooks/Cole Publishers.
6. Chatwal G.R., Anand S. K., Instrumental Methods of Chemical Analysis, 5th Edition, 2019, Himalya Publishing House, New Delhi.
7. Kaur H., Instrumental Methods of Chemical Analysis (Analytical Chemistry), 2012, Pragati Prakashan, Meerut.
8. Khopkar S.M., Basic Concepts of Analytical Chemistry, 2020, New Age International Publisher, New Delhi.

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Subject: Supramolecular Chemistry (Code-MSCYE-105)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	0	0
Course Instructor (s)	Dr. Ravi Kumar				

Course Objective	The course aims to provide a general overview and basic knowledge of supramolecular chemistry, emphasizing its character as a versatile and effective tool for building complex systems from well-defined units and their application in different areas of work and research.
Course Outcomes (COs)	
On successful completion of the course, the student will be able to about:	
CO1	Fundamentals of supramolecular chemistry
CO2	Molecular recognition using various supramolecular hosts.
CO3	Supramolecular reactivity and the applications of supramolecular systems in catalysis.
CO4	Applications of supramolecular systems as sensors and devices.
Module-I	**Fundamentals of Supramolecular Chemistry [7 L]** Terminology and definitions in supramolecular chemistry. Intermolecular forces: Ion pairing, ion-dipole and dipole-dipole interactions; hydrogen bonding; cation-pi, anion pi, pi-pi interactions and Van der Waal forces. Solvation and hydrophobic effect. Binding constants; definition and use.
Module-II	**Molecular Recognition [7 L]** Principle of molecular recognition, host-guest complementarity, pre-organization, chelate effect, cooperativity. Synthesis and applications of supramolecular host (Crown ethers, Porphyrin and other Tetrapyrrolic Macrocycles, cryptands, cyclodextrins) as cation and anion binding receptors and receptors for ion-pair recognition.
Module-III	**Supramolecular Reactivity and Catalysis [7 L]** Organocatalysis mediated through hydrogen bonding, preconcentration, self-assembly of catalysts and preorganisation of catalyst-substrate systems. Influence of organization (effective molarity) on catalysis, catalytic acyl transfer.
Module-IV	**Supramolecular devices [7 L]** Supramolecular Sensors and Devices –Thermochromism and Solvatochromism, Charge Transfer Complexes, theory of π- π stacking, Organic Light Emitting

	Diodes (OLEDs), transistors and organic lasers (elementary idea).

Recommended Books:

1. Principles and methods in Supramolecular chemistry by H. J. Schneider and A. Yatsimirsky, Wiley, New York, 2000.
2. Modern Supramolecular Chemistry by F. Diederich, P. J. Stang, R. T. Tykwinski, 2008.
3. Supramolecular Chemistry by J. W. Steed and J. L. Atwood, 2ndEdn John Wiley, 2009

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Subject: Environmental Chemistry (Code-MSCYE-106)	**Syllabus for M.Sc.- 1st Semester (1st Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	0	0
Course Instructor (s)	Prof. S. A. Shah				

Course Objective	To introduce the concepts of Environmental Chemistry, various aspects of the four main spheres of earth: Atmosphere, Biosphere, Hydrosphere and Lithosphere, their interactions amongst each other and their influence on human beings.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Environmental pollution.
CO2	Water pollution and its control.
CO3	Water treatment methods.
CO4	Water analysis.
Module-I	**Environmental pollution [7 L]** Structure of atmosphere- bio geological cycles -oxygen -nitrogen – carbon – phosphorous –sulphur - bio distribution of elements- air pollutions- reactions in atmosphere- primary pollutants -air quality standards - analysis of CO, nitrogen oxides, sulphur oxides, hydrocarbons and particulate matter - particulate pollution - control methods –vehicular pollution- greenhouse effect and global warming - climatic changes –ozone photochemical smog-acid rain - sampling - monitoring – control.
Module-II	**Water pollution [7 L]** Hydrological cycle- chemical composition - sea water composition -water quality criteria for domestic and industrial uses - BIS and WHO standards - ground water pollution-surface water pollution- lake and river water- eutrophication- marine pollution water pollutants - biodegradability of detergents –pesticides- microplastics.
Module-III	**Water treatment [7 L]** Principles of water and waste water treatment -aerobic and anaerobic treatment - industrial waste water treatment -heavy metal pollution-hard water - softening - purification of water for drinking purposes - water treatment for industrial use -

	electrodialysis - reverse osmosis- other purification methods - chemical specification of elements.
Module-IV	**Water analysis** **[7 L]** Colour - odour - conductivity - TDS - pH - acidity - alkalinity – chloride residual chlorine - hardness- trace metal analysis- elemental analysis -ammonia - nitrite - nitrate - fluoride - sulphide - phosphate -phenols - surfactants - BOD - COD – DO. Soil pollution: Soil humus - soil fertility- inorganic and organic components in soil -acid - base and ion exchange reactions in soils -micro and macro nutrients -waste and pollutants in soil- introduction to geochemistry- solid waste management- treatment and recycling- soil analysis- radioactive pollution- disposal of radioactive waste.

Recommended Books:

1. Environmental chemistry; A. K. De ; Wilay Eastern ; 1995.
2. Environmental chemistry; S. E. Manahan; Lewis Publishers; 2000
3. Environmental Sciences; Dr. R.J. Chhatwal; 2nd Revised Edition 2011.
4. Environmental Pollution analysis; S. M. Khopkar; Wiley Eastern.
5. Environmental Chemistry, L. W. Moore and E. A. Moore McGraw Hill Publication, New York, 2002.

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Subject: Tribochemistry of Lubricating Materials (Code-MSCYE-107)	**Syllabus for M.Sc.- 1st Semester (1st Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	0	0
Course Instructor (s)	Prof. Kowsar Majid				

Course Objective	The course has been designed to enable the students to learn the tribochemistry of various lubricating materials, their reaction mechanism and related surface chemistry. Related Environmental issues are also included at the end.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	To understand the area of tribochemistry
CO2	Aiming at main kinds of lubricants including oil additives, nanoparticles additives, ionic liquids, rare earth, ceramics, diamond like carbon films, organic thin films, and polymers. Studying the tribochemistry reaction mechanism, the structure and composition of reaction products to understand the failure mechanism and the theory of property regulation of lubricants
Module-I	**Introduction to the Tribochemistry Concept [14 L]** Introduction, lubricant additives, tribochemical interactions of additives, synthetic engine oils, lubricant requirements and specifications, Tribochemistry of oil additives, Tribochemistry of nanoparticle additives, The structure and tribology of ionic liquids, Tribochemistry of rare earth, Tceramics, diamond-like carbon films, Molecular structures and tribology of organic thin films, Tribochemistry of polymers.
Module-II	**Surface Tribochemistry, Activated Processes and Environmental Issues [14 L]** Chemical nature of metal surfaces, Catalytic activity of rubbing surfaces, Tribochemical reactions on surfaces, Organomolybdenum compounds in surface engines protection, lubricant additives, tribochemical interactions of additives, synthetic engine oils, lubricant requirements and specifications, Environmental issues: recyclability, biodegradability and toxicity, clean air and energy efficient cars.

Recommended Books:

1. Tribochemistry of Lubricating Oils, 1st Edition - December 2, 2003, **Author:** Zenon Pawlak, eBook ISBN: 9780080543260
2. Tribocatalysis, Tribochemistry and Tribocorrosion, 1st Edition, Edited by C Kajdas and K Hiratsuka, eBook ISBN: 978981431695

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Subject: Fundamentals of Analytical Techniques (Code-MSCYE-108)	**Syllabus for M.Sc.- 1st Semester (1st Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	0	0
Course Instructor (s)	Dr. Jignesh V. Rohit				

Course Objective	The course has been designed to enable the students to learn the basic analytical techniques to strengthen their basics and make ready to lean advance analytical techniques used for chemical analysis.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Volumetric methods and their application in qualitative chemical analysis.
CO2	Gravimetric methods for quantitative chemical analysis
CO3	Conductance of solutions and their measuring technique.
CO4	Solution potential and their application in titrations.
Module-I	**Volumetric Methods of Analysis [7 L]** Standard solutions, indicators, theory of indicators, types of volumetric titrations; acid-base, precipitation, redox, complexometric, theory of acid base indicators, Mohr, Volhard and Fajans methods, EDTA based titration, redox indicators and their use in volumetric analysis, iodometry and iodimetry, Problems.
Module-II	**Gravimetric Analysis [7 L]** Precipitation Methods, Impurities during precipitation, Purity of precipitation (Coprecipitation), Optimum Conditions, Washing and drying/Ignition of precipitates, Role of organic precipitants in gravimetric analysis, Precipitation Equilibria: The Solubility Product, Diverse Ion Effect on Solubility: Ksp and Activity Coefficients, Problems.
Module-III	**Potentiometric Methods [7 L]** General Principles, Reference Electrodes, Liquid-Junction Potentials, Indicator Electrodes (Liquid-Membrane Ion-Selective Electrode LMISE, Ion-Sensitive Field Effect Transistors ISFET, Instruments for Measuring Cell Potential (Error in Potential Measurements, Voltage Measurements), Direct Potentiometry, Potentiometric Titrations, Potentiometric Determination of Equilibrium

	Constants, Problems.
Module-IV	**Conductometric Methods [7 L]** Principle of Conductometric analysis, Measurement of conduction, Conductometric titrations (Strong Acid *Vs* Strong Base, Weak Acid *Vs* Strong Base, Strong Acid *Vs* Weak Base, Weak Acid *Vs* Weak Base, Mixture of a Strong Acid and Weak Acid *Vs* Strong Base or Weak Base), Dielectric constant, Measurement of dielectric constant, Direct Current conductivity analysis, Impedance measurement, Problems

Recommended Books:

3. Skoog D. A., Donald M. W., Holler F. J., Crouch S.R., Fundamentals of Analytical Chemistry, 10th Edition, 2022, Cengage Learning Publication.
4. Christian G. D., Dasgupta P. K., Schug K. A., Analytical Chemistry, 2020, Willey Publisher.
5. Willard H.M., Merritt L.L., Dean J.A., Settle F.A., Instrumental Methods of Analysis, 7th Edition, 2020, CBS Publisher.
6. Skoog D., Holler F., Crouch S., Principles of Instrumental Analysis, 7th Edition, 2017, Cengage Learning Publication.
7. Khopkar S.M., Basic Concepts of Analytical Chemistry, 3rd Edition, 2020, New Age International Publisher.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Organic Chemistry Lab-I (Code-MSCYL-109)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 1.5**		
Evaluation Scheme	Continuous Assessment	End-Term	L	T	P
	60 (Marks)	40 (Marks)	0	0	3
Course Instructor (s)	Prof. Tabassum Ara				

Course Objective	The course has been designed to enable the students to learn the organic chemistry practical skills.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Purification techniques.
CO2	Separation and purification of organic compounds.
CO3	Separation of a binary mixture of organic compounds.
CO4	Qualitative analysis of organic compounds.
Exp.1	**Purification techniques** (Demonstrations). Purification of solvents and reagents using Techniques like crystallization, sublimation, fractional distillation, vacuum distillation, drying and storage of solvents.
Exp.2-4	**Separation and Purification** Separation and Purification of organic compounds using thin layer chromatography and column chromatography. (Two exercises).
Exp.5-7	**Separation of a binary mixture** Separation of a binary mixture of organic compounds based on solubility in water and organic solvents. (Two exercises)
Exp.8-10	**Identification of the organic compounds** Identification of the organic compounds by systematic qualitative organic analysis (Two exercises).

Recommended Books:

1. Vishnoi N.K., Advanced Practical Organic Chemistry, 2nd ed. 1999, Vikas.
2. Pasto D., Johnson C., Miller M., Experiments and Techniques in Organic Chemistry, 1992, Prentice-hall.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Inorganic Chemistry Lab-I (Code-MSCYL-110)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 1.5**		
Evaluation Scheme	Continuous Assessment	End-Term	L	T	P
	60 (Marks)	40 (Marks)	0	0	3
Course Instructor (s)	Prof. S. A. Shah/Prof. Hamida Chisti				

Course Objective	To gain practical knowledge of inorganic chemistry.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Synthesis of Inorganic complexes.
CO2	Structure elucidation of the complexes.
CO3	Percentage of ions by titration methods.
CO4	Complexometric titration.
Exp.1	Synthesis of tris(acetylacetonato)manganese(III), $[Mn(C_5H_7O_2)_3]$.Calculate the percentage yield and give the structure of the complex. Also write the chemical reactions involved.
Exp.2	Synthesis of Copper(I) tetraiodomercurate (II), $Cu_2[HgI_4]$. Calculate the percentage yield and give the structure of the complex. Also write the chemical reactions involved.
Exp.3	Synthesis of pentaaminechlorocobalt(III) chloride, $[Co(NH_3)_5]Cl_2$. Calculate the percentage yield and give the structure of the complex. Also write the chemical reactions involved.
Exp.4	Synthesis of tris(acetylacetanato)Chromium(III), $[Cr(C_5H_7O_2)_3]$. Calculate the percentage yield and give the structure of the complex. Also write the chemical reactions involved.
Exp.5	Synthesis of nitropentaammine cobalt(III) chloride, $[Co(NH_3)_5NO_2]Cl_2$. Calculate the percentage yield and give the structure of the complex. Also write the chemical reactions involved.
Exp.6	Synthesis of Sodium trioxalato ferrate trihydrate. Calculate the percentage yield and give the structure of the complex. Also write the chemical reactions involved.
Exp.7	Synthesis of Mohr's Salt (Ferrous Ammonium Sulphate). Calculate the percentage yield and give the structure of the complex. Also write the chemical

	reactions involved.
Exp.8	Synthesis of Reinecke's salt (Ammonium Tetrathiocyanate diamine chromate). Calculate the percentage yield and give the structure of the complex. Also write the chemical reactions involved.
Exp.9	Synthesis of Hexaamine Nickel-II chloride. Calculate the percentage yield and give the structure of the complex. Also write the chemical reactions involved.
Exp.10	To estimate the percentage of copper ions in a given solution by titration method.

Recommended Books:

1. Vogel A. I., Qualitative Inorganic Analysis, 6th Edition, Revised, G. Svehla ELB–London.
2. Vogel A. I., Textbook of Chemistry Analysis.
3. Raj G., Advanced Practical Inorganic Chemistry, Goel Publishing House, Meerut.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Physical Chemistry Lab-I (Code-MSCYL-111)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 1.5**		
Evaluation Scheme	Continuous Assessment	End-Term	L	T	P
	60 (Marks)	40 (Marks)	0	0	3
Course Instructor (s)	Prof. Kowsar Majid/Dr. Shrikant Shivaji Maktedar				

Course Objective	To develop the experimental skills by providing practical course dedicated to physical chemistry.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Titrations using potentiometry
CO2	Coloumetric measurements.
CO3	Viscosity measurements.
CO4	Kinetics and surface reactions.
S. No.	**Details of the Experiments**
Exp.1	Titrate potentiometrically a phosphoric acid solution against NaOH and calculate pK_1, pK_2 and Pk_3 of the acid.
Exp.2	Determine redox potential of Fe^{2+}/Fe^{3+} system by titrating it with standard $K_2Cr_2O_7$ solution.
Exp.3	Determine λ_{max} for $KMnO_4$ by colorimetric measurement.
Exp.4	Verify Beer's law by colorimetric measurement.
Exp.5	Determine viscosity of given liquid by using Ostwald's viscometer.
Exp.6	Study variation of viscosity with composition of the mixture (any one).
Exp.7	Study the hydrolysis of ester in presence of hydrochloric acid.
Exp.8	Investigate the autocatalytic reaction between potassium permanganate and oxalic acid.
Exp.9	Investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir's isotherms.
Exp.10	Investigate the adsorption of acetic acid from aqueous solution by activated charcoal and examine the validity of Freundlich and Langmuir's isotherms.

Recommended Books:

1. Vogel A. I., A Text Book of Quantitative Inorganic Analysis, 3rd Edition.
2. Findary A., Kitchner T.A., Practical Physical Chemistry, Longmans, Green and Co.

3. Wilson J.M., Newcombe K.J., Denko A.R., Richett R.M.W., Experiments in Physical Chemistry, Pergamon Press
4. Khosla B.D., Garg V.S., Senior Practical Physical Chemistry, R. Chand and Co., Delhi.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Organic Reaction Mechanisms (Code-MSCYT-201)	**Syllabus for M.Sc.-2nd Semester (I Year)**		**Total Course Credit: 3**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	1	0
Course Instructor (s)	Dr. Ravi Kumar				

Course Objective	The course has been designed to enable the students to learn the various types of reactions and rearrangements in organic molecules.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Reaction mechanisms in organic chemistry.
CO2	Advance organic synthesis on account of additions to multiple bonds.
CO3	Molecular rearrangements of synthetic importance.
CO4	Orbital interactions in concerted reactions.
Module-I	**Substitution Reactions in Aromatic Compounds [11 L]** Electrophilic Substitutions: The arenium ion mechanism, orientation and reactivity, ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction. Nucleophilic Substitutions: The SNAr, SN1, benzyne and SRN1 mechanisms. Reactivity-effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements
Module-II	**Addition to Multiple Bonds [10 L]** Addition to carbon-carbon multiple bonds: General mechanism, reactivity, orientation and stereochemical implications of additions reactions involving electrophiles, nucleophiles and free radicals. Addition to cyclopropane ring. Hydrogenation of double/triple bonds and aromatic rings. Hydroboration. Addition to carbon-hetero atom double bonds: Mechanisms of addition of water, hydrogen cyanide, alcohols, amines, organometallic reagents and hydrides to aldehydes and ketones. Mechanism of Wittig, Mannich, Aldol, Cross Aldol, Cannizarro's, Knoevenagel, Robinson annulation, Claisen, Dickma, Benzoin, Perkin and Stobbes reactions
Module-III	**Molecular Rearrangements [11 L]** General mechanistic treatment of nucleophilic, electrophilic and free radical

	rearrangements. Nature of migration and migratory aptitude and memory effect. Detailed study of following rearrangements: Wagner-Meerwein, Pinacol-Pinacolone, Demyanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert, Neber, Hofmann, Curtius, Lossen, Schmidt, Beckmann, Baeyer-Villiger, Pyne and Dienone - phenol rearrangements.
Module-IV	**Pericyclic Reactions [10 L]** Molecular orbital symmetry, Frontier orbitals of ethene, 1,3- butadiene, 1,3,5-hexatriene and allylic systems. HOMO, LUMO concept, FMO approach. Classification of Pericyclic reactions. Woodward Hofmann rules for the following pericyclic reactions. Cycloadditions: Thermal and Photochemical 2+2 and 4+2 cycloadditions. Suprafacial and antrafacial cycloadditions. Electrocylic Reactions: Thermal and Photo-induced Electrocyclic reactions of 4n and 4n+2 systems and their stereochemistry. Conrotatory and disrotatory motions. Sigmatropic rearrangements: Classification, [1,3], [1,5] and [3,3] sigmatropic shifts. Cope and Claisen rearrangements. Suprafacial and antrafacial shifts of hydrogen atom.

Recommended Books:

1. Kurti L., Czako, B., Strategic Applications of Named Reactions in Organic Synthesis, 2004.
2. Dupey C., Chapman O., Molecular Reactions and Photochemistry, 2006, Prentice Hall.
3. Mukherjee S.M., Singh S. P., Reaction Mechanism in Organic Chemistry, 2009, Macmillan India Limited.
4. Nasipuri D., Stereochemistry of Organic Compounds, 2nd Edition, 2007, New Age International.
5. Gilchrist T. L., Heterocyclic Chemistry, 3rd Edition, 2007, Pearson Education.
6. Bansal R. K., Heterocyclic Chemistry, 5th Edition, 2006, New Age International.
7. Carruthers W., Modern Methods of Organic Synthesis, 4th Edition, 2007, Cambridge University Press.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Bio-inorganic & Nuclear Chemistry (Code-MSCYT-202)	**Syllabus for M.Sc.-2nd Semester (I Year)**		**Total Course Credit: 3**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	1	0
Course Instructor (s)	Prof. S. A. Shah/ Prof. Hamida Chisti				

Course Objective	The course has been designed to enable the students to learn the details of bio-inorganic chemistry and basics of nuclear chemistry.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Bioinorganic chemistry of elements.
CO2	Biochemical reactions in living systems.
CO3	Metals in enzymes and medicine: anti-cancer agents, diabetes, arthritis, radionuclides and related applications.
CO4	Nuclear changes or processes including fission, fusion and decay reactions.
Module-I	**Metal ions in Biochemical Systems [11 L]** Introduction to bio-inorganic chemistry, Concept of essentiality, Criteria and classification of essential elements as per their role in living systems, Bulk metals and trace metals, Role of alkali and alkaline earth metals in biosystems, Metal ion toxicity, Na^+ - K^+ pump, Transport and storage of Iron (Ferritin, Transferrin and siderophores).
Module-II	**Metalloporphyrins, Respiration & Electron Transport in Biosystems [10 L]** Metalloporphyrins, Cytochromes (Cytochromes C, Cytochrome C-oxidase, Cytochrome P-450). Dioxygen transport (hemocyanin and hemerythrin), Structure and physiological role of hemoglobin and myoglobin, Bohr Effect and cooperativity, Chloride effect, Iron-Sulfur proteins, Ferredoxins, Rubredoxin, Copper proteins, Enzymes and co-enzymes, Structure and function of carboxypeptidase A, Carbonic anhydrase, Xanthine oxidase, Vitamin B12.
Module-III	**Enzymes and medicinal Chemistry [11 L]** Enzymes and co-enzymes, Structure and function of carboxypeptidase A, Carbonic anhydrase, Xanthine oxidase, Vitamin B12, Nitrogen fixation, Biochemical basis of essential metal deficient diseases and their therapies (Iron, Zinc, Copper and Manganese). Chelate therapy, Anticancer drugs-cisplatin,

	Auranofin and arthritis treatment, Vanadium complexes in medicine.
Module-IV	**Nuclear Chemistry** **[10 L]** Introduction, Nuclear binding energy, Mass defect and binding energy, The average binding energy per nucleon. Radioactivity: Nuclear emissions, nuclear transformations, The kinetics of radioactive decay, Units of radioactivity. Artificial isotopes: Bombardment of nuclei by high-energy a-particles and neutrons, Bombardment of nuclei by 'slow' neutrons. Nuclear fission: The fission of uranium-235, The production of energy by nuclear fission, nuclear reprocessing. Syntheses of trans uranium elements. The separation of radioactive isotopes: Chemical separation, The Szilard–Chalmers effect. Nuclear fusion. Applications of isotopes: Kinetic isotope effects, Radiocarbon dating.

Recommended Books:

1. Huheey J.E., Inorganic Chemistry, 4th Edn., 2008, Pearson.
2. Miessler G. L., Tarr D.A., Inorganic Chemistry, 3rd Edn., 2008, Pearson.
3. Catherine E., Croft H., Sharpe A. G., Inorganic Chemistry, 2nd Edn., 2005.
4. Cotton F. A., Wilkinson G., Murillo C. A., Bochmann M., Advanced Inorganic Chemistry, 6th Edn., 1999, Wiley.
5. Weller and Armstrong, Inorganic Chemistry, 6th Edn., 2015, Oxford.
6. Lee J. D., Concise Inorganic Chemistry, 5th Edn., 1999, Wiley,
7. Gupta B.D., Elias A.J., Organometallic Chemistry, 2nd Edn., 2013, University Press.
8. Cotton F. A., Chemical Applications of Group Theory, 3rd Edn., 2008, John Wiley & Sons.
9. Atkins and Shriver, Inorganic Chemistry, 5th Edn., 2009.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Advanced Electrochemistry & Chemical Kinetics (Code-MSCYT-203)	**Syllabus for M.Sc.-2nd Semester (I Year)**		**Total Course Credit: 3**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	1	0
Course Instructor (s)	Prof. Kowsar Majid/Dr. Shrikant Shivaji Maktedar				

Course Objective	The course has been designed to enable the students to learn the electrochemistry and chemical kinetics.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Electrochemistry and semiconductors.
CO2	Electrochemistry of redox systems.
CO3	Theories of chemical reactions.
CO4	Surface chemistry.
Module-I	**Electrochemistry-I [10 L]** Metal-electrolyte electrified interfaces, Concept of surface excess, Thermodynamics of electrified interface, Lippmann equation, Electrocapillary curves, Methods for determination of surface excess. Structural models of metal-electrolyte interface: Helmholtz-Perrin, Gouy-Chapman and Stern models, Semiconductor electrodes: Structure of semiconductor/electrolyte interface, Theories of heterogeneous electron transfer: Electron transfer at electrified interface at and away from equilibrium, Butler-Volmer Equation, Low and high field approximations, Significance of transference-coefficient. Marcus theory of charge transfer.
Module-II	**Electrochemistry -II [12 L]** Electrochemistry of redox enzymes: Direct and mediated electron transfer, Enzyme modified electrodes-challenges and applications. Mechanism and approach to bio-electrosynthesis, examples of bio-electrosynthesis-oxidation of alcohols, synthesis of dihydroxyl acetone phosphate, site specific oxidation of sugars, reduction of carbonyl compounds, hydrogenation. Solar Cells: Principles of Operation and Energetics of Conversion, Photoelectrochemical splitting of water, Photoelectrochemical reduction of CO_2 and N_2.
Module-III	**Chemical Kinetics-I [10 L]**

	Micro kinetic analysis of reaction rates and orders. Fast reactions: General features of fast reactions, Study of fast reactions by flow method, Relaxation method and flash photolysis. Theories of chemical reactions: Arrhenius theory, Collision theory and its limitations, Potential energy surfaces, Activated complex theory of reaction rates, Statistical and thermodynamic formulations, Comparison with collision theory. Theories of unimolecular reactions (Lindman and Hinshelwood theories, RRK theory).
Module-IV	**Chemical Kinetics-II** **[10 L]** Surface Reactions: Unimolecular & bimolecular surface reactions, Langmuir-Hinshelwood and Langmuir-Riedel mechanism, Classical and Statistical treatments. Reactions in liquid solutions: Diffusion controlled reactions (partial and full microscopic diffusion control), Ionic reactions: Single and double sphere models of ionic reactions, Ionic strength effect, Catalysis: introduction to catalysis, Mechanism of catalysis, Use of solvents as catalysts, Enzyme catalysis, Michaelis–Menten Equation, Inhibition, Effects of pH and Temperature on enzyme catalysis reactions.

Recommended Books:

1. Bockris J. O., Reddy A.K., Modern Electrochemistry, 1, 2A, 2nd Edn., 2002, Kluwer Academic/plenum Publishers, New York.
2. Bard A. J., Faulkner L. R., Electrochemical methods, Fundamentals and Methods, 2nd Edn.; 2002, Wiley.
3. Gileadi E., Physical Electrochemistry-Fundamentals, Techniques and Applications, 2011, Wiley-VCH.
4. Hamann C. H., Hammett A., Vielstich W., Electrochemistry, 2nd Edn., 2007, Wiley-VCH.
5. Margaret R. W., An Introduction to Aqueous Electrolyte Solutions, Ist Edn., 2007, Wiley.
6. Atkins P. W., Physical Chemistry, 2010, Oxford.
7. Laidler K. J., Chemical Kinetics, 4th Edn., Revised, 2002, Mcgraw-Hill.
8. Masel R. I., Chemical Kinetics and Catalysis, 2001, Wiley.
9. Steinfeld J. I., Francisco J. S., Hase W. L., Chemical Kinetics and Dynamics, 2nd Edn.; 1998.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Chromatographic Techniques (Code-MSCYT-204)	**Syllabus for M.Sc.-2nd Semester (I Year)**		**Total Course Credit: 3**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	1	0
Course Instructor (s)	Dr. Mohammad Aslam/Dr. Jignesh V. Rohit				

Course Objective	The course has been designed to enable the students to learn the analysis of experimental data and learn various analytical techniques which would be applied in all areas of research and various industries.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Gas chromatography.
CO2	Liquid chromatography like high-performance liquid chromatography.
CO3	Ion and ion-exchange chromatography.
CO4	Size exclusion and super critical fluid chromatography.
Module-I	**Gas Chromatography [11 L]** Introduction to chromatography, classification of chromatographic methods, planar and column chromatography techniques. Principle of gas chromatography, instruments; carrier gases; columns and stationary phases; sample injection systems, detectors-characteristics of the ideal detectors, thermal conductivity detector, flame ionization detector, thermionic detector, mass spectrometer detector, factors affecting the efficiency of the column, qualitative analysis, Kovats retention index (I), quantitative analysis, analyses based on peak height and peak areas, numeric problems based on gas chromatography, applications of gas chromatography.
Module-II	**High Performance Liquid Chromatography [10 L]** Principle of HPLC, stationary and mobile phases in HPLC, instrumentations; isocratic and gradient elution, mobile phase delivery system, sample injection system, separation columns and column packings, detectors-absorbance, fluorescence, refractive-index and electrochemical detectors, basic difference between HPLC and conventional liquid chromatography, hyphenated techniques viz. HPLC-MS, advantages and applications of HPLC.
Module-III	**Ion & Ion-Exchange Chromatography [11 L]** Principles of separation, ion-exchange equilibria and selectivity, types of

	stationary phases, mobile phases, effect of pH on separation of amino acid, effect of complexing agent on separation of metal ions, distinction between ion-exchange and ion chromatography, ion-suppression in ion chromatography, ion chromatography with eluent suppressor column, single column ion chromatography, properties of mobile phases, detectors, applications.
Module-IV	**Size Exclusion and Super Critical Fluid Chromatography [10 L]** Size Exclusion Chromatography; Principles of separation, theoretical basis-calibration curve, exclusion limit, total permeation and selective permeation regions, relation between elution volume and molecular weight, packing materials and applications. Super critical fluids and its properties, principle, instrumentation, stationary and mobile phases, detectors, operating variables, comparisons with other types of chromatography, applications.

Recommended Books:

1. Miller J. M., Chromatography: Concepts and Contrasts, 2nd Edition, 2004, Wiley-Interscience.
2. Harold M. M., Miller J. M., Nicholas H. S., Basic Gas Chromatography, 3rd Edition, 2019, Willey.
3. Meyer V. R., Practical High-Performance Liquid Chromatography, 5th Edition, 2010, Willey.
4. Raymond P.W. S., Introduction to Analytical Gas Chromatography, Volume 76, 2017, CRC Press.
5. Robert L. G., Eugene F. B., Modern Practice of Gas Chromatography, 4th Edition, 2008, Wiley-Interscience.
6. Miller L. M., Pinkston J. D., Taylor L. T., Modern Supercritical Fluid Chromatography: Carbon Dioxide Containing Mobile Phases (Chemical Analysis: A Series of Monographs on Analytical Chemistry and Its Applications, 2019, Wiley.
7. Kaur H., Instrumental Methods of Chemical Analysis (Analytical Chemistry), 2012, Pragati Prakashan, Meerut.
8. Chatwal G.R., Anand S.K., Instrumental Methods of Chemical Analysis, 5th Edition, 2019, Himalya Publishing House, New Delhi.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Bio-Molecules (Code-MSCYE-205)	**Syllabus for M.Sc.- 2nd Semester (1st Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	0	0
Course Instructor (s)	Prof. J. A. Banday				

Course Objective	The course has been designed to enable the students to learn the structure and Functions of Bio-molecules.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Carbohydrates, their structure and classification.
CO2	Structure, reactions and functions of amino acids and proteins.
CO3	Nucleic acids and their role in living systems.
CO4	Lipids in daily life.
Module-I	**Carbohydrates** **[7 L]** Classification of carbohydrates: Monosaccharides: Structure with special reference to glucose and fructose, Configuration, Reactions, Anomers, epimers and epimerization, mutarotation. Chain shortening and lengthening Disaccharides and polysaccharides; brief idea.
Module-II	**Amino Acids and Proteins** **[7 L]** Amino acids: structure and classification of amino acids, iso-electric point, Polypeptides and proteins; structure of proteins (Primary, secondary, tertiary & quaternary), classification of proteins. Peptide synthesis in laboratory.
Module-III	**Nucleic Acids** **[7 L]** Introduction, structure and classification of nucleic acids, Nucleosides, Nucleotides, base pairing in DNA. Functions of nucleic acids; Nucleic acids and heredity, replication of DNA, protein synthesis, mutations.
Module-IV	**Lipids** **[7 L]** Classification, Fats and Oils, Fatty acids, Steroids, triglycerides, Phospholipids, Soaps and detergents.

Recommended Books:

1. Clayden, J. Greeves, N., Warren, S., Wothers, P., Organic Chemsitry, 3rd. Edition Oxford University Press,

2. U. Satyanarayanan and U. Chakrapani, Biochemistry, 4th. Edition-2013, (Elsevier).
3. John McMurry, Eric Simanek, Fundamentals of Organic Chemistry, 7th. Edition, (Cengage India Pvt. Ltd.)
4. David L. Nelson and Michael M. Cox, Principles of Biochemistry, 6th. Edition-2013 (Lehenger).

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Group Theory (Code-MSCYE-206)	**Syllabus for M.Sc.- 2nd Semester (1st Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	0	0
Course Instructor (s)	Prof. S.A. Shah/Prof. Hamida Chisti				

Course Objective	To introduce the concepts of Group theory.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Molecular symmetry.
CO2	Symmetry classification of molecules
CO3	Orthoganality theorem.
CO4	Applications of group theory
Module-I	**Molecular Symmetry [7 L]** Symmetry elements and operations: Identity, rotation axis, reflection plane, inversion center, improper rotation axis. Combination of symmetry operations, Introductory idea to permutation group. Group multiplication tables.
Module-II	**Symmetry Classification of Molecules [7 L]** Symmetry groups, Point groups. Schoenflies notation of point groups. Identification of point groups. Matrices and their combination, block factored matrices, Matrix representation of symmetry operations.
Module-III	**The Great Orthoganality Theorm- [7 L]** Elementary idea, consequences of the Great Orthogonolity Theorem. Reducible and Irreducible representations (IRs), Mullikan symbols for IRs, Properties of IRs. Character table-construction of character tables for C2v, C3v and C4v point groups.
Module-IV	**Applications of group theory: [7 L]** Applications of group theory to IR and Raman spectroscopy. Degrees of freedom/molecular motions-Vibrational motions. Selection rules. Symmetry of IR and Raman active normal vibrational modes of AB2, AB3, AB4, AB5, and AB6 type molecules. Applications of symmetry to Molecular Chirality, Polarity and

	hybridization. Projection Operators (Elementary Idea).

Recommended Books:

1. Chemical Applications of Group Theory; 2nd edn.;
2. F. A. Cotton; Wiley Eastern; (1994) 2. Molecular Symmetry and Group Theory; L. Carter; Wiley; 1998.
3. Symmetry and Spectroscopy of Molecules; K. Veera Reddy; New Age 1998.
4. Inorganic Chemistry, Principles of structure and reactivity; 4th Edition.
5. Physical Methods for Chemists; R.S.Drago; 2nd edn; Saunders; 1992.

DEPARTMENT OF CHEMISTRY
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Subject: Energy Conversion & Storage Systems (Code-MSCYE-207)	**Syllabus for M.Sc.- 2nd Semester (1st Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	0	0
Course Instructor (s)	Dr. Shrikant Shivaji Maktedar				

Course Objective	The course has been designed to enable the students to understand & learn the energy conversion & storage systems through electrochemical techniques.
Course Outcomes (COs)	
On successful completion of the course, the student will be able to about:	
CO1	Fundamentals of working of supercapacitors & battery.
CO2	Interfacial phenomenon through double layer at capacitor electrode interface.
CO3	Kinetics of electrode processes.
CO4	Electrostatics involved in capacitor electrode interphases.
Module-I	**Supercapacitor & Battery [7 L]** Modes of Electrical Energy Storage by Capacitors and Batteries, Faradaic and Non-Faradaic Processes, Types of Capacitors and Types of Batteries, Differences of Densities of Charge Storage in Capacitors and Batteries, Comparison of Capacitor and Battery, Li Intercalation Electrodes-A Transition Behavior, Charging of a Nonideally Polarizable Capacitor Electrode, Properties of Electrochemical Capacitors and Batteries.
Module-II	**Double Layer at Capacitor Electrode Interfaces [7 L]** Models and Structures of the Double Layer, Two-Dimensional Density of Charges in the Double Layer, Ionic Charge Density and Interionic Distances on the Solution Side of the Double Layer, Electron-Density Variation: "Jellium" Model, Electric Field across the Double Layer, Double-Layer Capacitance and the Ideally Polarizable Electrode, Equivalent Circuit Representation of Double-Layer Electrical Behavior.
Module-III	**Kinetics of Electrode Processes [7 L]** Energetics of Electrode Processes, Energy Factors in Relation to Electrode Potential, Kinetics of Electrode Reactions at Metals, Currents and Rate Equations, Linearization of the Butler-Volmer, Equation for Near-Equilibrium Conditions (low η), Graphical Representation of the Exchange Current Density,

	i_0 and Behavior Near Equilibrium, Onset of Diffusion Control in the Kinetics of Electrode Processes, Kinetics when Steps Following an Initial Electron Transfer are Rate Controlling, Double-Layer Effects in Electrode Kinetics, Electrical Response Functions Characterizing Capacitative Behavior of Electrodes.
Module-IV	**Elements of Electrostatics Involved in Treatment of Double Layers and Ions at Capacitor Electrode Interphases [7 L]** Electrostatic Principles, Coulomb's Law: Electric Potential and Field, and the Significance of the Dielectric Constant, Lines of Force and Field Intensity-A Theorem, Capacity of a Condenser or Capacitor, Field Due to a Surface of Charges: Gauss's Relation, Poisson's Equation: Charges in a 3-Dimensional Medium, The Energy of a Charge .

Recommended Books:

1. Electrochemical Supercapacitors: Scientific Fundamentals & Technological Applications, B. E. Conway
2. Electrochemical Methods: Fundamentals & Applications, Allen J Bard, Larry R Faulkner, Second Edition, John Wiley & Sons Inc.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Spectrochemical Methods (Code-MSCYE-208)	**Syllabus for M.Sc.- 2nd Semester (1st Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	0	0
Course Instructor (s)	Dr. Mohammad Aslam/Dr. Jignesh V. Rohit				

Course Objective	The course has been designed to enable the students to learn the principles and working of spectrochemical methods, widely used for routine and research at academia and industries.
Course Outcomes (COs)	
On successful completion of the course, the student will be able to about:	
CO1	Absorption spectroscopy and its application in qualitative and quantitative measurements.
CO2	Fluorescence spectroscopy and its use in analysis of chemical and biological species.
CO3	Mass spectrometry and application
CO4	Fourier transform mass spectrometer (HRMS).
Module-I	**Molecular Absorption Spectrometry [7 L]** Ultraviolet and Visible Molecular Absorption Spectroscopy (Absorption by Organic and Inorganic Compounds, Charge-Transfer Absorption, Qualitative Applications of Ultraviolet/Visible Spectroscopy, Quantitative applications, The Relationship between Absorbance and Concentration, Standard Addition Method, Analysis of Mixtures, Photometric and Spectrophotometric Titrations), Automated Photometric and spectrophotometric Methods (Flow-Injection Analysis).
Module-II	**Molecular Fluorescence Spectroscopy [7 L]** Theory of Molecular Fluorescence (Relaxation Processes, Fluorescence and Structure, Effect of Structural Rigidity, Temperature and Solvent Effects), Effect of Concentration on Fluorescence Intensity, Fluorescence Instrumentation, Applications of Fluorescence Methods (Determination of Organic, Inorganic and biochemical species), Molecular Phosphorescence Spectroscopy, Chemiluminescence Methods.

Module-III	**Mass spectrometry** **[7 L]** Introduction, principle of mass spectrometry, ion production, electron ionization (EI), chemical ionization (CI), field ionization (FI), mass to charge ratio. Mass spectrometers, components of mass spectrometer, sample handling system, ionization chamber, electrostatic accelerating system, ion separator, ion collector, vacuum system, mass analyzers, sector analyzer, quadrupole mass analyzer, time of flight mass analyzer, transducers for mass spectrometry, resolution, applications of mass spectrometry to volatiles/non-volatiles.
Module-IV	**High Resolution Mass Spectrometry** **[7 L]** Introduction to advanced mass spectrometry, high resolution mass spectrometry (HR-MS), Fourier transform mass spectrometer (FT-MS), principle of Fourier-transform mass spectrometer, instrumentation, detection, scanning, working, applications of FTMS to volatiles and non-volatiles. Advanced hyphenated techniques of analysis; GC-MS, HPLC-MS, UPLC-MS and their applications.

Recommended Books:

4. Skoog D., Holler F., Crouch S., Principles of Instrumental Analysis, 7th Edition, 2017, Cengage Learning Publication.
5. Willard H.M., Merritt L.L., Dean J.A., Settle F.A., Instrumental Methods of Analysis, 7th Edition, 2020, CBS Publisher.
6. Harvey D., Modern Analytical Chemistry, 2000, McGraw Hill Education, New York.
7. Skoog D. A., Donald M. W., Holler F. J., Crouch S.R., Fundamentals of Analytical Chemistry, 10th Edition, 2022, Cengage Learning Publication.
8. Patnaik P., Analytical Chemistry Handbook, Second Edition, McGraw Hill Education.
9. D. Kealey, P. J. Haines, Analytical Chemistry, BIOS Scientific Publishers Limited, 2002.
10. David Sparkman, Zelda Penton and Fulton G. Kitson, Gas Chromatography and Mass Spectrometry: A Practical Guide, 2nd Ed., Elsevier, 2011, ISBN: 978-0-12-373628-4.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Organic Chemistry Lab-II (Code-MSCYL-209)	**Syllabus for M.Sc.-2nd Semester (I Year)**		**Total Course Credit: 1.5**		
Evaluation Scheme	Continuous Assessment	End-Term	L	T	P
	60 (Marks)	40 (Marks)	0	0	3
Course Instructor (s)	Prof. Tabassum Ara/Prof. J. A. Banday/Dr. Ravi Kumar				

Course Objective	The course has been designed to enable the students to learn the organic chemistry practical skills.
Course Outcomes (COs)	
On successful completion of the course, the student will be able to about:	
CO1	Synthesis of organic compounds.
CO2	Isolation of natural products
CO3	Characterization of organic compounds by IR spectroscopy.
CO4	Determination of the λ_{max} of organic compounds.
Exp.1-4	**Preparations of the following compounds** 1. Aspirin from salicylic acid 2. Haloform reaction: Preparation of Iodoform. 3. Nitrobenzene to m-dinitrobenzene to m-nitroaniline 4. Benzophenone_Benzophenoneoxime_Benzanilide (Beckmannrearrangement) 5. Aniline to Diazonium salt to p-Aminoazobenzene 6. Glucazone from glucose 7. Benzoin to Benzil to BenzilicAcid
Exp.5-6	**Isolation of** 1. Caffeine from tealeaves 2. Lycopene from tomatoes 3. Casein from milk
Exp.7-8	**Detection of functional groups** using IR spectroscopy in a given organic compound (Two exercises).
Exp.9-10	**Determination** of λ_{max} for a given organic compound using UV-Vis spectrophotometer. (Two exercises).

Books Recommended:

1. Vishnoi N.K., Advanced Practical Organic Chemistry, 2nd ed., 1999, Vikas.

2. Pasto D., Johnson C., Miller M., Experiments and Techniques in Organic Chemistry, 1992, Prentice-hall.
3. Williamson K.L., Microscale and Macroscale Organic Experiments, 1989, D.C. Heath and Co.
4. Tatchell A.R., Vogel's Textbook of Practical Organic Chemistry, 5th ed.- 1996.
5. Ahluwalia V. K., Aggarwal R., Comprehensive Practical Organic Chemistry, 2000, University Press.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Inorganic Chemistry Lab-II (Code-MSCYL-210)	**Syllabus for M.Sc.-2nd Semester (I Year)**		**Total Course Credit: 1.5**		
Evaluation Scheme	Continuous Assessment	End-Term	L	T	P
	60 (Marks)	40 (Marks)	0	0	3
Course Instructor (s)	Prof. S. A. Shah/Prof. Hamida Chisti				

Course Objective	To gain practical knowledge of Inorganic Chemistry.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Synthesis of coordination complexes.
CO2	Structure elucidation of inorganic complexes.
CO3	Spectrophotometric determination.
CO4	Estimation of metal ions.
Exp.1	Synthesis of dichlorobis (triphenylphosphine) cobalt (II).
Exp.2	Synthesis of tris (2,4-pentadionato) chromium (III).
Exp.3	Synthesis of tris (2,4-pentadionato) manganese (III).
Exp.4	Synthesis of dichlorobis (triphenylphosphine) nickel (II).
Exp.5	Synthesis of Ammonium dodecamolbedophosphate.
Exp.6	Synthesis of cis-Potassium Dioxalato diaqua chromate (III) i.e., cis-$K[Cr(C_2O_4)_2(H_2O)_2]$.
Exp.7	Synthesis of Tetra ammine copper (II) Sulphate monohydrate i.e. [Cu(NH3)4]SO4.H2O.
Exp.8	Synthesis of tris (ethylenediamine) cobalt (III) chloride.
Exp.9	Synthesis of Mercurytetrathiocyanatocobaltate (II).
Exp.10	Determination of the amount of (Fe^{2+}) in the given sample spectrophotometrically using 1,10-phenanthroline.

Recommended Books:

1. Vogel A. I., Qualitative Inorganic Analysis, 6th Edition Revised, G. Svehla ELB–London.
2. Vogel A. I., Textbook of Chemistry Analysis.
3. Raj G., Advanced Practical Inorganic Chemistry, Goel Publishing House, Meerut.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Physical Chemistry Lab-II (Code-MSCYL-211)	**Syllabus for M.Sc.-2nd Semester (I Year)**		**Total Course Credit: 1.5**		
Evaluation Scheme	Continuous Assessment	End-Term	L	T	P
	60 (Marks)	40 (Marks)	0	0	3
Course Instructor (s)	Prof. Kowsar Majid/Dr. Shrikant Shivaji Maktedar				

Course Objective	To develop the experimental skills by providing the practical course dedicated to the physical chemistry.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Conductometric titration.
CO2	pH-metry measurements.
CO3	Colorimetric titration.
CO4	Potentiometry, colorimetry and kinetics.
S. No.	**Details of the Experiments**
Exp.1	Determine the concentration of KCl solution by titrating it with standard $AgNO_3$ conductometrically.
Exp.2	Determine amount of trichloroacetic acid, monochloroacetic acid and acetic acid in given solution by conductometric titration against sodium hydroxide solution.
Exp.3	Determine pKa value of given organic acid by pH measurement.
Exp.4	Determine acidic and basic dissociation constant of amino acid and hence isoelectric point of the acid.
Exp.5	Determine simultaneous dichromate and permanganate ions in the given acid by colorimetric measurements.
Exp.6	Determine concentration of Cu^{2+} ion in given solution titrating with EDTA solution by colorimetric measurements.
Exp.7	Titrate ferrous ammonium sulphate with ceric sulphate and hence find out formal redox potential of Fe^{2+}/Fe^{3+} and Ce^{3+}/Ce^{4+} system.
Exp.8	To determine basicity and pKa value of given organic acid by potentiometric measurements.
Exp.9	Determine indicator constant of given indicator by colorimetric measurements.
Exp.10	Study the hydrolysis of ethyl acetate in presence of sodium hydroxide.

Recommended Books:

1. Vogel A. I., A Text Book of Quantitative Inorganic Analysis, 3rd Edition.
2. Findary A., Kitchner T.A., Practical Physical Chemistry, Longmans, Green and Co.
3. Wilson J.M., Newcombe K.J., Denko A.R., Richett R.M.W., Experiments in Physical Chemistry, Pergamon Press
4. Khosla B.D., Garg V.S., Senior Practical Physical Chemistry, R. Chand and Co., Delhi.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Organic Spectroscopy and Modern Organic Synthesis (Code-MSCYT-301)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 3**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	1	0
Course Instructor (s)	Prof. Tabassum Ara				

Course Objective	The course has been designed to enable the students to learn various spectral techniques and designing the synthesis of organic molecules.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Organic structure determination using spectroscopic techniques.
CO2	Photochemical excitation/de-excitation events.
CO3	Modern synthetic methods used in functional group transformations.
CO4	Retrosynthetic approach in the art of modern organic synthesis.
Module-I	**UV, IR Spectroscopy and Mass Spectrometry [11 L]** UV Spectroscopy: Electronic transitions in organic molecules, Woodward-Fieser rules for alkenes, Woodward rules for enones and aromatic compounds IR Spectroscopy: IR frequencies of alkanes, alkenes, alkynes, aromatic compounds, and for all other functional groups. Effects of hydrogen bonding and solvent on vibrational frequencies, overtones, combination bands and Fermi resonance. Mass spectrometry: Basic principles, hard and soft ionization techniques, mass analyzer in ESI-MS and MALDI-MS, high resolution MS, isotope abundance, molecular ion, fragmentation processes (McL) of organic molecules, deduction of structure through mass spectral fragmentation, molecular ion peak, metastable peak, McLafferty rearrangement. Nitrogen rule High resolution mass spectrometry.
Module-II	**Nuclear Magnetic Resonance Spectroscopy [10 L]** Basic concepts, Mechanism of Measurements, Chemical shift values for various classes of compounds. Fourier Transform (FT) Techniques and advantages, Nuclear OVERHAUSER effect (NOE). One bond coupling, two bond coupling, three bond coupling, second order spectra A_2, AB, AX, AB_2, AX_2, A_2B_2. Proton exchange, deuterium exchange, Peak broadening exchange
Module-III	**Photochemistry [11 L]**

	Photochemical Reactions, Interaction of electromagnetic radiation with matter. Types of excitations. Singlet and triplet states and their lifetimes. Fate of excited molecule: Physical and chemical processes. Transfer of excitation energy: Sensitization and Quenching. Photochemistry of alkenes, Geometrical isomerisations, cyclisation and dimerization reactions. Photochemical reactions of 1,3- butadiene (excluding pericyclic reactions). Rearrangements of 1,4 and 1,5- dienes. Photochemistry of saturated carbonyl compounds, Intramolecular reactions of saturated acyclic and cyclic carbonyl compounds. (Norrish type-I and Norrish type-II processes). Intermolecular cycloaddition reactions (Paterno- Buchi reaction). Photochemistry of unsaturated carbonyl compounds, Photochemical reactions of α, β-unsaturated carbonyl compounds. (H-Abstraction and isomerization to β, γ-unsaturated carbonyl compounds). Photolysis of cyclic α, β- unsaturated ketones (dimerization and lumiketone rearrangement) and cyclohexadienones.
Module-IV	**Designing Organic Synthesis** **[10 L]** Retrosynthetic analysis: Basic principles and terminology of retrosynthesis, guidelines, one group and two group C-X disconnections, one group C-C and two group C-C disconnections, amine and alkene synthesis, important functional group interconversions, reversal of polarity (umpolung). Protection and deprotection of functional groups: Protection and de-protection of hydroxy, carboxyl, carbonyl, amino acids.

Books Recommended:

1. Smith M.B., Organic Synthesis, 3rd Ed., 2010, Academic Press.
2. Warren S., Wyatt P., Organic Synthesis: The Disconnection Approach, 2nd Edition, 2008, Wiley-VCH.
3. Carey F.A., Sundberg R.J., Advanced Organic Chemistry, Part B: Reactions and Synthesis, 5th Edition, 2007, Plenum.
4. Clayden J., Greeves N., Warren S., Organic Chemistry, 2nd Ed., 2012, Oxford.
5. Kemp W., Organic Spectroscopy, 3rd Edition, 2009, Macmillan.
6. Pavia D. L., Lanyman G. M, Introduction to Spectroscopy, 3rd Edition, 2008, Thompson Publishers.
7. Kalsi P.S., Spectroscopy of Organic Compounds, 6th Edition, 2004, New Age International Publishers.
8. Sharma Y. R., Elementary Organic Spectroscopy-Principles and Applications, 5th Edition, 2007, S. Chand Publishers.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Organometallic Chemistry (Code-MSCYT-302)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 3**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	1	0
Course Instructor (s)	Prof. S.A. Shah				

Course Objective	To familiarize the students to the synthesis, structure and reactivity of metal carbonyls, nitrosyls, metal clusters and organometallic reactions.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Study of metal carbonyls in organometallic chemistry.
CO2	Synergistic effect of ligands in metal complexes.
CO3	Spectral analysis, Metal-Metal bonding & clusters of organometallic complexes.
CO4	Industrially important homogenous catalysis cycles.
Module-I	**Metal Carbonyls [11 L]** Organic Ligands and Nomenclature. The 18-electron Rule: Counting electrons in octahedral, tetrahedral and square planar complexes. Ligands in Organometallic chemistry: Carbonyl complexes, Ligands similar to carbonyl, hydride and dihydrogen complexes, ligands having extended pi systems. Bonding between metals and organic pi systems: Linear pi systems, cyclic pi- systems, and fullerene complexes. Complexes containing M-C, M=C and M≡C bonds: Alkyl and related complexes, Carbene and Carbyne complexes.
Module-II	**Metal Nitrosyls [10 L]** Introduction, modes of bonding of NO as NO^+, Nitrosylating agents for synthesis of metal nitrosyls, Structure, bonding and important reactions of transition metal nitrosyls, Vibrational spectra for structural elucidation and bondig in metal nitrosyls. Structure of Roussins red and black salts. Dinitrogen, dioxygen and tertiary phosphine as Ligands. Bonding Schemes.
Module-III	**Metal Clusters [11 L]** Spectral analysis and characterisation of organometallic complexes: Infra-red spectra and NMR spectra. The Isolobal Analogy: Extensions of the Analogy. Metal-Metal bonds, Multiple Metal-Metal bonds. Cluster compounds: Boranes, Heteroboranes, Metallo-boranes and MetalloCarboranes, Carbonyl Clusters,

	Carbide Clusters. Metal Halide Clusters: major structural types in Dimuclear Metal-Metal systemsEdge Sharing Bioctahedra, face sharing Bioctahedra, Tetragonal prismatic and trigonal antiprismetic structures, Quadruple bonds, Structure and bonding in $(Re_2Cl_8)^{2-}$.
Module-IV	**Organometallic Reactions [10 L]** Reactions involving gain or loss of ligands: Ligand dissociation and substitution, oxidative addition, reductive elimination, nucleophilic displacement. Reactions involving modification of ligands: Insertion, Carbonyl insertion (Alkyl migration), 1, 2 Insertions, Hydride elimination, abstractions. Organometallic Catalysis: examples of Catalysis (Catalytic Deuteration), Hydroformylation, Monsanto acetic acid process, Wacker (Smidt) process, Hydrogenation by Wilkinson's Catalyst, Olefin Metathesis. Heterogeneous catalyst: Ziegler-Natta Polymerization and water gas reaction.

Recommended Books:

1. Huheey J.E., Inorganic Chemistry, 4th Edn., 2008, Pearson.
2. Miessler G. L., Tarr D.A., Inorganic Chemistry, 3rd Edn., 2008, Pearson.
3. Cotton F. A., Wilkinson G., Murillo C. A., Bochmann M., Advanced Inorganic Chemistry, 6th Edn., 1999, Wiley.
4. Weller and Armstrong, Inorganic Chemistry, 6th Edn., 2015, Oxford.
5. Lee J. D., Concise Inorganic Chemistry, 5th Edn., 1999, Wiley,
6. Gupta B.D., Elias A.J., Organometallic Chemistry, 2nd Edn., 2013, University Press.
7. Cotton F. A., Chemical Applications of Group Theory, 3rd Edn., 2008, John Wiley & Sons.
8. Atkins and Shriver, Inorganic Chemistry, 5th Edn., 2009.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Solid State Chemistry & Thermodynamics (Code-MSCYT-303)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 3**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	1	0
Course Instructor (s)	Prof. Kowsar Majid				

Course Objective	The course has been designed to enable the students to learn the solid-state chemistry and thermodynamics.
Course Outcomes (COs)	
On successful completion of the course, the student will be able to about:	
CO1	Solid-state chemistry
CO2	Conductors and superconductors
CO3	Advanced statistical thermodynamics
CO4	Irreversible thermodynamics
Module-I	**Solid State Chemistry-I** **[10 L]** Point groups, Space groups, Lattice Planes and Miller indices, Bragg's equation, Debye-Scherer method of X-ray structural analysis, Identification of cubic unit cells from systematic absences in diffraction pattern, Structure factor and its relation to intensity and electron density. Crystal structure of Perovskite (SrTiO3) and Rutile (TiO2). Thermodynamics of Schottky and Frenkel defect formation. Theories of bonding in solids: Somerfield's model, Density of states and its significance. Band theory of solids in light of Kroning-Penny model.
Module-II	**Solid State Chemistry-II** **[10 L]** Semiconductors: Intrinsic and extrinsic semiconductor (n-type and p-type), Temperature dependence of charge carriers, p-n junction- devices based on p-n junction (tunnel diode, injection laser). Magnetism in solids: Origin of Magnetism, Diamagnetism, paramagnetism (classical and quantum mechanical treatment), ferromagnetism, ferrimagnetism and anti-ferromagnetism in solids. Super conductors: Characteristic properties- Zero resistance, Meissner effect, Heat capacity, Thermal conductivity, Absorption of electromagnetic radiations and Josephson effect. BCS theory of superconductivity, Applications.
Module-III	**Irreversible Thermodynamics** **[12 L]** Basic principles of non-equilibrium thermodynamics: Second law of thermodynamics for open systems, law of conservation of mass, charge and

	energy. Irreversible processes and uncompensated heat, degree of advancement, reaction rate & affinity of a reaction. Relation of uncompensated heat to other thermodynamic functions. Entropy production, entropy production due to matter flow, heat flow, charge flow and chemical reactions; entropy production and efficiency of galvanic cells. Concept of forces and fluxes, Onsager's theory of irreversible processes, phenomenological laws, their domain of validity. Principle of microscopic reversibility and Onsager relations, Chemical reactions near equilibrium. Curie–Prigogine principle. Transformation properties of forces and fluxes.
Module-IV	**Statistical Thermodynamics [10 L]** Ensembles-canonical, grand canonical and micro canonical Combinatorial problems, Thermodynamics probability and most probable distribution, Starlings approximation, distribution laws, the law of equipartition of energies. Quantum statistics- Max Well-Boltzmann, Bose-Einstein and Fermi-Dirac, limit and applicability of various distribution laws. Molecular Partition Function: Partition function, Expression for translational, rotational, vibrational and electronic partition functions, Third law of thermodynamics and partition function, Numerical problems.

Recommended Books:

1. Azaroff, Introduction to Solids, 1993, Tata McGraw.
2. West A. R., Solid State Chemistry and its Applications, 1989, Wiley.
3. Ashcroft N. W., Mermin N. D., Solid State Physics, 2001, Saunders College.
4. Srivastava J.P., Elements of Solid-State Physics, 2003, Prentice Hall of India.
5. Atkins P. W., Physical Chemistry, 2010, Oxford

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Advanced Instrumentation Techniques (Code-MSCYT-304)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 3**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	1	0
Course Instructor (s)	Dr. Jignesh V. Rohit				

Course Objective	The course has been designed to enable the students to learn the analysis of experimental data and learn various analytical techniques which would be applied in all areas of research and various industries.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Raman Spectroscopy and its applications in analysis of Inorganic, Organic and biological Species.
CO2	Mossbauer Spectroscopy and its use in chemical analysis.
CO3	X-ray methods like XRD, XRF, XPS/ESCA, AES methods.
CO4	Advanced electron microscopy techniques like SEM & TEM.
Module-I	**Raman Spectroscopy [11 L]** Theory (Excitation of Raman Spectra, Mechanisms of Raman and Rayleigh Scattering, Wave Model of Raman and Rayleigh Scattering, Intensity of Normal Raman Bands, Raman Depolarization Ratios), Instrumentation (Sources, Sample-Illumination System, Raman Spectrometers), Applications of Raman Spectroscopy (Raman Spectra of Inorganic, Organic and biological Species and Quantitative Applications), Other Types of Raman Spectroscopy (Resonance Raman Spectroscopy, Surface-Enhanced Raman Spectroscopy, Nonlinear Raman Spectroscopy), Problems.
Module-II	**Mossbauer Spectroscopy [10 L]** Principle of Mossbauer Spectroscopy (Nuclear γ-ray resonance, Hyperfine spectra, Modulation of energy, Isomeric shift, Quadrupole splitting, Magnetic splitting), Instrumentation (Source, sample compartment and detectors), Interpretation of Mossbauer spectra, Application of Mossbauer Spectroscopy in analysis of Inorganic and biological samples, Problems.
Module-III	**X-ray Methods of Analysis [11 L]** Introduction to X-ray methods, generation of X-rays, X-ray Diffraction; principle,

	theory, instrumentation, chemical analysis with X-ray diffraction and applications. X-ray Fluorescence; principle, instrumentation, chemical analysis and applications. X-Ray photoelectron spectroscopy (XPS/ESCA); principle, chemical shifts as a function of oxidation states, instrumentation, applications; Auger electron spectroscopy (AES); principle, instrumentation-radiation source, energy analyzer, detector, auxiliary system; applications.
Module-IV	**Electron Microscopy** **[10 L]** Introduction to electron microscopy, classifications of electron microscopy, scanning electron microscopy (SEM); fundamentals, significance of secondary electrons, backscattered electrons and X-ray photons, sample preparation, instrumentation, applications. Transmission electron microscopy (TEM); Introduction, basic theory, electron gun, electromagnetic lens, condenser lens, objective lens, projector lenses, imaging, operating parameters-magnification, resolution, depth of field; sample preparation, specimen orientation, comparative analysis of SEM and TEM, applications.

Recommended Books:

1. Skoog D., Holler F., Crouch S., Principles of Instrumental Analysis, 7th Edition, 2017, Cengage Learning Publication.
2. Willard H.M., Merritt L.L., Dean J.A., Settle F.A., Instrumental Methods of Analysis, 7th Edition, 2020, CBS Publisher.
3. Khopkar S.M., Basic Concepts of Analytical Chemistry, 3rd Edition, 2020, New Age International Publisher.
4. Hollas J. M., Modern Spectroscopy, 4th Edition, 2013, Wiley.
5. Goldstein J., Newbury D.E., Joy D.C., Lyman C. E., Scanning Electron Microscopy and X-Ray Microanalysis, 3rd Edition, 2013, Springer.
6. Echlin P., Fiori C.E., Goldstein J., Joy D. C., Newbury D. E., Advanced Scanning Electron Microscopy and X-Ray Microanalysis, 2013, Springer.
7. Hamid A., A Beginners' Guide to Scanning Electron Microscopy, 2019, Springer.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Applied Organic Chemistry (Code-MSCYE-305)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	0	0
Course Instructor	Prof. Tabassum Ara				

Course Objective	The course has been designed to enable the students to learn the Chromatographic techniques, role of food additives, drugs and enzymes.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Chromatographic techniques.
CO2	Food additives.
CO3	Drugs in curing various diseases.
CO4	Enzymes and their activity.
Module-I	**Chromatographic Techniques [7 L]** Introduction, applications of chromatography, various types of chromatographic techniques. Thin layer chromatography, Paper chromatography, Column chromatography.
Module-II	**Food Additives [7 L]** Introduction, Various types of food additives and their role. Food preservatives, various nutritious additives. Sweetening agents: Natural and Artificial.
Module-III	**Drugs [7 L]** Introduction, chemotherapy, classification of drugs, Antipyretics, Analgesics, Antibiotics, Diuretics, Disinfectants, Antiseptics, Antihistamines, Tranquilizers, Antiacids.
Module-IV	**Enzymes [7 L]** Introduction, Nomenclature and classification, Chemical nature and Properties of enzymes, Factors affecting enzyme activity.

Recommended Books:

1. R.F. Doerge, Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, J.Lippincott Co., Philadelphia.
2. Burger's Medicinal Chemistry and Drug Discovery, Vol. I. Principle and Practice, 5th,
3. Handbook of Food Preservation by M. Shafiur Rahman. Edition, John Wiley Sons, New York.

4. Chromatography: Concepts and Contrasts by James, M. Miller, Wiley Online Library First Edition 2009.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Nanotechnology (Code-MSCYE-306)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	0	0
Course Instructor	Prof. Hamida Chisti				

Course Objective	To impart the basic knowledge on nanotechnology which includes the exotic properties of materials at nanoscale, various techniques available for the processing and characterization of nanostructured materials and their applications.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Basic knowledge of nanotechnology.
CO2	Synthesis and applications of metal oxide-based nanocomposites.
CO3	Synthesis and applications of conducting polymer-based nanocomposites.
CO4	Synthesis and applications of biopolymer-based nanocomposites.
Module-I	**Fundamentals of nanotechnology [7 L]** Fundamentals of nanotechnology, introduction to nano-scale, nanocomposites, Advanced Inorganic materials, Nanotechnology & its industrial application, potential application of inorganic nanomaterials. General methods of Preparation: Top-down approach and bottom-up approach for synthesis of nanomaterial, Ball milling, Sol-gel method, Solution based method, Solvothermal synthesis, and photochemical synthesis.
Module-II	**Metal-Oxide based nanocomposites: [7 L]** Metal-Oxide based nanocomposites: General introduction about metal oxide nanocomposites, Types of metal oxide nanocomposites, Synthesis of metal oxide nanocomposites (Top-down approach and bottom-up approach, Sol- gel method, hydrothermal method, Sonochemical method, Ball milling, etc.), Applications of metal oxide nanocomposites [Sensing (Metal sensing, Gas sensing), Photocatalysis (drug degradation, dye degradation), Mechanism of Photocatalysis.
Module-III	**Conducting polymer-based nanocomposites: [7 L]** Conducting polymer-based nanocomposites: General introduction of conducting polymer-based nanocomposites (Polypyrrole, polyaniline, Polythiophene, and

	PEDOT-PSS) Types of conducting polymer-based nanocomposites, Synthesis of Conducting polymer-based nanocomposites (Precipitation method, Co-precipitation method, Sol-gel method, In-Suti chemical polymerization), Applications of conducting polymer-based nanocomposites [Sensers, Photocatalysis, electrochemical catalysis, energy storage, and antimicrobial activity.
Module-IV	**Biopolymer-based nanocomposites: [7 L]** Biopolymer-based nanocomposites: General introduction of Biopolymer-based nanocomposites (Starch, Chitosan, Gelatin, Pectin, Alginate, and Cellulose), Types of biopolymer-based nanocomposites, Synthesis of biopolymer-based nanocomposites (Precipitation method, Co-precipitation method, Sol-gel method, In-Situ chemical polymerization, and Top-down approach and bottom-up approach), Applications of conducting polymer-based nanocomposites Heavy metal adsorption, Drug delivery, Food packaging, antimicrobial activity.

Recommended Books:

1. Cao G., Nanostructures and Nanomaterials–Synthesis, Properties and
2. Applications, 2004, Imperial College Press, London.
3. Rao C. N. R., Muller A., Cheetham A. K., The Chemistry of Nanomaterials, Volume 1,
4. 2004, Wiley –VCH Verlag GmbH & Co. KGaA, Weinheim.
5. Ozin G. A., Aresnault A. C., Cadematriri L. Nanochemistry: A chemical approach to nanomaterials, 2008, RSC Publishing.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Organic Flexible Electronics Materials (Code-MSCYE-307)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	0	0
Course Instructor	Prof. Kowsar Majid				

Course Objective	The course has been designed to enable the students to learn the organic electronics, processing and their potential applications
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	To understand the area of organic electronics
CO2	Student may understand latest developments in the field of organic semiconductor materials and devices
Module-I	**Materials, Processing and Device Physics [14 L]** *p*-Conjugated Polymers for OLEDs, Organic Vapor-Phase Deposition, Charge Transport and Injection in Amorphous Organic Semiconductors, Magnetic Field Effects in Organic Semiconducting Materials and Devices, Interface in Organic Semiconductor Devices: Dipole, Doping, Band Bending, and Growth, Interfaces in Organic Electronic Devices—New Insights to Traditional Concepts, The Role of Homolytic Reactions in the Intrinsic Degradation of OLEDs, Materials and Interface Engineering in Organic Light-Emitting Diodes.
Module-II	**Organic Electronic Devices and Applications [14 L]** Microcavity Effects in Organic Light-Emitting Devices, Vertical-Type Organic Transistors, Routes toward High-Efficiency Polymer Solar Cells, Mixed Molecular Heterojunction Photovoltaic Cells, Development of Polymer Semiconductors for Field-Effect Transistor Devices in Displays, OLED Materials and Device Architectures for Full-Color Displays and Solid-State Lighting, Organic Light-Emitting Diodes and Photodetectors for Optical Communication, Organic Light-Emitting Diodes in Chemical and Biological Sensors.

Recommended Books:

1. Organic Electronics Materials, Processing, Devices and Applications, Edited By Franky So, 2010, CRC Press
2. Organic Electronics: Foundations to Applications , by Stephen R. Forrest, OUP Oxford, ISBN-10 : 0198529724, ISBN-13: 978-0198529729,2020
3. Organic Electronics 1: Materials and Physical Processes, Thien-Phap Nguyen, 2021, Print ISBN:9781786303219 |Online ISBN:9781119818946
4. Organic Flexible Electronics: Fundamentals, Devices, and Applications, 2020, **Editors:** Piero Cosseddu, Mario Caironi, Paperback ISBN: 9780128188903, 978-0-12-818890- 3 ,eBook ISBN: 9780128188910

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Polymer Chemistry (Code-MSCYE-308)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
26 (Marks)	24 (Marks)	50 (Marks)	2	0	0
Course Instructor	Dr. Mohammad Aslam				

Course Objective	The course has been designed to enable the students to learn about the new field of materials like polymers and their role in daily life.
Course Outcomes (COs) On successful completion of the course, the student will be able to about:	
CO1	Polymerization methods and average molecular weight of polymers.
CO2	Kinetics of polymerization.
CO3	Characterization techniques of polymers.
CO4	Applications of polymers for commercial purposes.
Module-I	**Polymers and Polymerization [7 L]** Polymers and polymerization, classification of polymers based on; source, chemical nature, thermal response, ultimate form and branched/network structures, raw material for the synthesis of polymers, petroleum and petrochemicals, methods of polymer synthesis- free radical, cationic, anionic, coordination, condensation, copolymerization, stereoselective polymerization and their mechanism. Molecular weights of polymers, number average, weight average, Z- average, viscosity average, degree of polymerization, polydispersity and molecular weight distribution in polymers, the practical significance of molecular weight.
Module-II	**Kinetics of polymerization [7 L]** Kinetics of free radical chain polymerization, equation for kinetic chain length, degree of polymerization, chain transfer reactions, the Mayo equation and evaluation of chain transfer constant, ceiling temperature, cationic polymerization, anionic polymerization, polycondensation, noncatalyzed polycondensation, acid catalyzed polycondensation, molecular weight distribution, ratio of weight average molecular weight to number average molecular weight, extent of reaction and degree of polymerization.
Module-III	**Characterization of polymers [7 L]** Preliminary tests, elemental analysis, solubility chart, specific end group

	analysis (acid value, hydroxyl value, iodine value, epoxy value, SAP value, amine value), spectroscopic analysis (IR, NMR & ESR). Solubility chart for identification of polymers, specific chemical tests for various polymers and group analysis, thermal analysis (TGA, DTA, DSC) of polymers, microscopy (SEM & TEM).
Module-IV	**Specialty polymers [7 L]** Polyimides and related specialty polymers, ionic polymers, inorganic polymers, liquid crystal polymers, main chain and side chain liquid crystalline polymers. Conducting polymers, synthesis & applications of polyacetylenes, polyanilines, polypyrroles & polythiophines. Photoresponsive and photorefractive polymers. Polymers in optical lithography, organic electronic materials, polymers for medical applications, biopolymers and biodegradable polymers, drug delivery-drug carriers, polymer-based nanoparticles.

Recommended Books:

5. F.W. Billmayer, Textbook of Polymer Science. 3rdEdn, Wiley. N.Y. 1991.
6. Joel R Fried, Polymer Science and Technology, Prentice Hall, 1999.
7. P. Ghosh, Polymer Science and Technology of Plastics and Rubbers, Tata Mc Hill, Prentice Hall, 2000.
8. George Odian, Principles of polymerization, 4th edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2004.
9. J.M.G Cowie. Polymers: Physics and Chemistry of Modern Materials. Blackie. London, 1992.
10. R. J. Young, Principles of Polymer Science, 3 rdEdn. Chapman and Hall. N.Y. 1991.
11. F. Ullrich, Industrial Polymers, Kluwer, N.Y. 1993.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Analytical Chemistry Lab (Code-MSCYL-309)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 1.5**		
Evaluation Scheme	Continuous Assessment	End-Term	L	T	P
	60 (Marks)	40 (Marks)	0	0	3
Course Instructor (s)	Dr. Mohammad Aslam				

Course Objective	To develop the experimental skills by providing hands on experience of various sophisticated analytical techniques used in Chemistry and to make the student competent to design, perform and analyse the experiments by using these techniques.
Course Outcomes (COs)	
On successful completion of the course, the student will be able to about:	
CO1	Thermograms using TGA/DTG method and solid-liquid extraction using Soxhlet apparatus.
CO2	Analytical techniques like HPLC, FTIR.
CO3	Titrations using potentiometry, conductometry and pH-metry.
CO4	Chromatographic separation to identify the mixture's components.
S. No.	**Details of the Experiments**
Exp.1	Study the thermal decomposition of calcium oxalate monohydrate/magnesium oxalate dihydrate using TGA/DTG.
Exp.2	Extraction of oils from ground nuts using Soxhlet unit.
Exp.3	Determination of iodine value of an oil sample using Wijs method.
Exp.4	Separation of drug (paracetamol) components of by HPLC technique.
Exp.5	Quantitative analysis of APC tablet (antibiotic) by FTIR spectroscopy.
Exp.6	Determination of dissociation constant of an amino acid and the isoelectric point of the acid.
Exp.7	Determination of ferrous ammonium sulphate potentiometrically with standard ceric sulphate solution.
Exp.8	Determination of strength of strong and weak acids in a given mixture conductometrically.
Exp.9	Spectrophotometric determination (in ppm) of Fe (II) or Fe (III) using 1,10

	Phenanthroline (or thiocyanate) as colorimetric reagent.
Exp.10	Separation of mixture of amino acids using thin layer chromatography (TLC).

Recommended Books:

1. Wilson J. M., Newcombe R. J., Denaro A. R., Experiments in Physical Chemistry, 2013, Pergamon Press.
2. Svehla, Sivasankar, Vogel's Qualitative Inorganic Analysis, 2012, Pearson Education India.
3. Khosla B.D., Garg V.C., Gulati A., Senior Practical Physical Chemistry, Publisher-R. Chand and Co., Delhi.)
4. Vishwanathan B., Raghavan P.S., Practical Physical Chemistry, 2012, Viva Books Press.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

Subject: Computer Methods in Chemistry Lab (Code-MSCYL-310)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 1.5**		
Evaluation Scheme	Continuous Assessment	End-Term	L	T	P
	60 (Marks)	40 (Marks)	0	0	3
Course Instructor (s)	Dr. Jignesh V. Rohit				

Course Objective	The programs objective map to knowledge of software to address needs in chemistry and related areas.
Course Outcomes (COs)	
On successful completion of the course, the student will be able to about:	
CO1	MS Office in formula creation, calculation of correlation coefficient, proposal writing and presentation.
CO2	Orgin software in graph plotting and getting value of correlation coefficient.
CO3	ChemDraw software in drawing of chemical structures and estimating structural prosperities.
CO4	Mathtype software in writing of statistical and mathematical equations.
S. No.	**Details of the Experiments**
Exp.1	To understand functions and create formulas using Microsoft Excel worksheet.
Exp.2	To learn the process of calculating the value of correlation coefficient using Microsoft Excel Worksheet.
Exp.3	To lean research proposal writing and preparation of research presentation using MS Word/MS Power Point.
Exp.4	To draw the UV/FTIR spectrum and HPLC/Gas Chromatogram using Origin software.
Exp.5	To lean process of preparing linear fittings of graphs and getting value of correlation coefficient using Origin software.
Exp.6	To understand functions ChemDraw software and lean to draw the structures of simple aliphatic and aromatic molecules.
Exp.7	Lean to draw the structures of complex aliphatic and aromatic molecules using ChemDraw software.
Exp.8	To learn the process of determining molecular formula, molecular weight and elemental percentage of chemical structures using ChemDraw software.
Exp.9	To understand functions of Mathtype software and lean to write simple

	equations.
Exp.10	To learn to write complex statistical and mathematical equations using Mathtype software.

Recommended Software:

1. MS Office Software, Latest version.
2. Origin Software, Latest version.
3. ChemDraw Software, Latest version.
4. Mathtype Software, Latest version.