Programme Structure

M.Sc. Chemistry (Two Year Full Time Programme)

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**
1.	MCY- 101	Structure, Reactivity and Stereochemistry of Organic Molecules	4	0		4	1.	MCY- 201	Organic Reaction Mechanisms	4	0		4
2.	MCY- 102	General Inorganic Chemistry	4	0		4	2.	MCY- 202	Coordination Chemistry, Organometallics & Group Theory	4	0		4
3.	MCY- 103	Concepts in Physical Chemistry	3	1		4	3.	MCY- 203	Surface and Solid State Chemistry	3	1		4
4.	MCY- 104	Instrumental Methods of Chemical Analysis	3	1		4	4.	MCY- 204	Chromatographic Techniques	4	0		4
5.	MCY-105P	Inorganic Practical-I			4	2	5.	MCY-205P	Inorganic Practical-II			4	2
6.	MCY-106P	Organic Practical-I			4	2	6.	MCY-206P	Organic Practical-II			4	2
7.	MCY-107P	Physical Practical-I			4	2	7.	MCY-207P	Physical Practical-II			4	2
	Total Hrs/Credits		**28**			**22**		**Total Hrs/Credits**		**28**			**22**

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**
1.	MCY- 301	Organic Spectroscopy and Modern Organic Synthesis	4	0		4	1.	MCY- 401P	Project Work/Dissertation			30	15
2.	MCY- 302	Bio-inorganic & Nanotechnology	4	0		4							
3.	MCY- 303	Advanced Physical Chemistry	3	1		4							
4.	MCY- 304	Advanced Instrumentation Techniques	4	0		4							
5.	MCY-305P	Analytical Chemistry Lab			4	2							
6.	MCY-306P	Computational Methods in Chemistry Lab			4	2							
7.	MCY-307P	Pre-project Seminar			2	1							
	Total Hrs/Credits		**26**			**21**		**Total Hrs/Credits**		**30**			**15**

SUMMARY					
Semesters	Sem-I	Sem-II	Sem-III	Sem-IV	Overall
Credits	22	22	21	15	80

It is proposed that there will be 80 credits spread over the entire course. There will be 22, 22, 21 and 15 credits for I, II, III and IV semesters, respectively. Each semester will consist of four theory courses of 4 credits each and three lab courses of 2 credits each. In fourth/final semester there will be complete project work of six months duration with 15 credits. Thus, the total minimum credits required for completing the M.Sc. in Chemistry is 80.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Structure, Reactivity and Stereochemistry of Organic Molecules (Code-MCY-101)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 4**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	4	0	0

Course Objective	The course has been designed to enable the students to learn the structure, reactivity and stereochemistry of organic molecules.
Course Outcomes (COs)	
CO1	To learn and apply various electronic effects and concept of aromaticity to understand the basics of advance organic reactions.
CO2	To learn the involvement of reactive intermediates and understand their structure and reactivity through various organic reactions.
CO3	To impart the knowledge of structure-reactivity and the reaction mechanism.
CO4	To learn the stereochemistry of organic compounds at an advanced level. Stereo chemical implications on the structure, and reactivity of organic molecules.
UNIT-I	**Nature of Bonding in Organic Molecules [10 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. Carcinogenesis due to aromatic hydrocarbons. Molecular orbital diagram of annulenes, Frost diagram.
UNIT-II	**Reaction Mechanism: Structure and Reactivity [10 L]** Reactive Intermediates: Generation, Structure, fate and stability of Carbocations (Classical and Non- Classical), Carbanions, Free radicals, Carbenes, Nitrenes, Arynes and Radical ions.

	Determination of Reaction Mechanism: Types of mechanisms, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle, transition states and intermediates, methods of determing rxn mechanism isotope effects. Hard and soft acids and bases. Effect of structure on reactivity - resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation
UNIT-III	**Stereochemistry** **[10 L]** Conformations: Origin of conformational energy. Angle and Pitzer strain. Conformational analysis of cycloalkanes, and decalines. 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 centres, Threo and erythro isomers. Configuration-Relative (D, L) and absolute configuration (R, S) configurations. Optical activity due to chiral axis, chiral plane and helicity. Chirality involving atoms other than carbon. Chirality in metallic complexes. Enantiotopic and diastereotopic atoms, groups and faces. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes) Asymmetric Synthesis: Introduction, principle of asymmetric synthesis. Categories of asymmetric synthesis, stereo-specificity and stereo-selectivity of organic reactions.
UNIT-IV	**Aliphatic Electrophilic Substitutions** **[10 L]** Bimolecular mechanisms; SE2 and SE1. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity. Aromatic Electrophilic Substitutions The arenium ion mechanism, orientation and reactivity, energy profile diagrams. 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. 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.

Recommended Books:

1. March's Advanced Organic Chemistry Reactions, Mechanism and Structure, 6th Ed., Smith, M.B. (Wiley-2014)
2. Organic Chemistry 8th Ed. - F. A. Carey and Robert M. Giuliano (McGraw Hill-2012).
3. Reaction Mechanism in Organic Chemistry 3rd Ed., S.M. Mukherjee and S.P. Singh. (Macmillan- 1998).
4. Stereochemistry of Organic Compounds 2nd Ed., D. Nasipuri. (New Age Inter.- 2008)
5. Stereochemistry of Carbon Compounds - E.L.Eliel. (TMH -2007)
6. Stereochemistry of Organic Compounds 7th Ed. - P.S. Kalsi. (New Age Inter.- 2012).
7. Organic Chemistry - 2nd Ed., J. Hornback. (Brooks/Cole- 2006,
8. Organic Chemistry, 5th Ed., John McMurry. (Brooks/Cole-2000).
9. Advanced Organic Chemistry, 5th Ed., F.A Carey & R.J Sundberg (Springer-2007).
10. Organic Chemistry, 2nd Ed., Jonathan Clayden (OUP-2012)
11. Organic Chemistry, 11th Ed., Solomons, T.W.G., (Wiley-2015).

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: General Inorganic Chemistry (Code-MCY-102)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 4**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	4	0	0

Course Objective	The course aims at understanding the structural paradigms in main group and early transition elements, and their rings, cages and cluster compounds. To understand the chemistry and reactivity of transition elements, lanthanides and actinides, their properties and applications. The course also aims at the detailed interception of bonding concepts in coordination and organometallic compounds.
Course Outcomes (COs)	
CO1	To understand the structure and reactivity of main group compounds.
CO2	To learn about the chemistry and applications of Transition and Inner-transition elements.
CO3	To learn about the theories, bonding and structure of coordination and organometallic compounds.
CO4	To learn about the spectral analysis, Metal-Metal bonding & clusters of organometallic complexes.
UNIT-I	**Chemistry of Main Group Elements [10 L]** 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, PSEPT theory, Capping principle, Electron precise molecules. Introduction, properties, structure, bonding, organometallic chemistry, synthesis and reactivity of organo lithium, beryllium, and magnesium compounds. Boron, aluminum, gallium, indium organyls, germanium, tin and lead organyls, multiple bonded compounds, cages, clusters, applications in organic synthesis.
UNIT-II	**Chemistry of Transition & Inner Transition Eleme nts [10 L]**

	Transition elements & their compounds (structure, Bonding theories, spectral & magnetic properties). 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, organometallic chemistry, applications in organic synthesis. Transactinides.
UNIT-III	**Coordination Chemistry-I [10 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, magnitudes of eσ, eπ and Δ. The Jahn Teller effect: octahedral and tetrahedral Complexes.
UNIT-IV	**Organometallic Chemistry-I [10 L]** Organic Ligands and Nomenclature. The 18-electron Rule: Counting electrons in octahedral, tetrahedral and square planar complexes. Ligands in Organometalic 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. 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 Metallo Carboranes, Carbonyl Clusters, Carbide Clusters.

Recommended Books:

1. Inorganic Chemistry, James E. Huheey, Pearson. 4th Edn.
2. Inorganic Chemistry, Gary L. Miessler, Donald A. Tarr, Pearson, Third Edn.
3. Inorganic Chemistry, F.A. Cotton, Wiley, 6th Edn.
4. Inorganic Chemistry, Weller and Armstrong, Oxford, 6th Edn.
5. Inorganic Chemistry, J. D. Lee, Wiley, 5thEdn.

DEPARTMENT OF CHEMISTRY
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Subject: Concepts in Physical Chemistry (Code-MCY-103)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 4**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	3	1	0

Course Objective	The course has been designed to enable the students to learn the concepts of physical chemistry.
Course Outcomes (COs)	
CO1	To get knowledge of concepts in thermodynamics.
CO2	To learn the principles of chemical kinetics.
CO3	To gain knowledge about electrical current in ionic solution.
CO4	To acquire the knowledge about the colloidal state and polymer science.
UNIT-I	**Thermodynamics [10 L]** Second Law of Thermodynamics, Criteria for Reversible and Irreversible Processes, Maxwell's Equations and Gibbs-Helmholtz Equation. Fugacity and Activity: Determination of Fugacity of Gas and Mixture, Activity and Activity Coefficient and Their Determination Nernst Heat Theorem, Third Law of Thermodynamics, Determination of Absolute Entropies of Solids, Liquids and Gases. Thermodynamics of Open Systems: Partial Molar Properties and Their Significance, Gibbs-Duhem Equation.
UNIT-II	**Chemical Kinetics [10 L]** Theories of Chemical Reactions: Collision Theory of Reaction Rate, Activated Complex Theory, Statistical & Thermodynamic Formulations, Comparison with Collision Theory.Lindemann Theory, Hinshelwood's Theory, Kassel, Rice and Ramsperger Theory (RRK), RRKM Theory, Kinetics of Opposing or Reversible Reaction, Kinetics of Consecutive Reaction, Kinetics of Chain Reaction, Kinetics of Branched Chain Reaction, Fast Reactions: General Features of Fast Reactions, Study of Fast Reactions by Flow Method, Relaxation Method and Flash Photolysis. Reactions in Solutions: Diffusion Controlled Reactions, Ionic Reactions; Single & Double Sphere Models of Ionic Reactions.

UNIT-III	**Electrical Current in Ionic Solution [10 L]** Conductance of Electrolytic Solutions, Specific Conduction, Equivalent Conduction, Molar Conduction, Variation of Molar Conduction with Dilution, Ionic Mobility, Transport Number, Determination of Transport Number, Kohlrausch's Law, Calculation of Molar Ionic Conductance, Relationship between Molar Ionic Conduction and Ionic Mobility, Debye Huckel Theory of Strong Electrolytes.
UNIT-IV	**Colloidal State [10 L]** Colloidal Systems, Properties of Colloidal System, Electrical Properties, Electrical Double Layer, DLVO Theory, Electrokinetic Properties, Surfactants, Micelle Formation, Critical Micelle Concentration (CMC), Thermodynamics of Micellization, Micellar Catalysis, Emulsification, Theories of Emulsion Macromolecules: Macromolecules, Classification of Polymers and Polymerization Reactions, Molar Masses of Polymers, Determination of Molar Masses of Macromolecules, Viscometry, Osmometry, Donnan Membrane Equilibrium

Recommended Books:

1. Principles of Physical Chemistry: Puri, Sharma, Pathania, Latest Edition
2. Text Book of Physical Chemistry - S. Glasstone (McMillan), Latest Edition
3. Modern Electrochemistry, Vol 1,2A and 2B, John O" M Bokris, Latest Edition
4. An Introduction to Electrochemistry, Samuel Glasstone, Latest Edition
5. Theoretical Electrochemistry, L.Antropov. Latest Edition
6. Advanced Physical Chemistry, Gurtu and Gurtu. Latest Edition

DEPARTMENT OF CHEMISTRY
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Subject: Instrumental Methods of Chemical Analysis (Code-MCY-104)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 4**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	3	1	0

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)	
CO1	To get knowledge of data handling/statistical treatment of data.
CO2	To learn the principles of titrimetric analysis and its significance in analytical chemistry.
CO3	To gain knowledge about different types of electroanalytical techniques.
CO4	To acquire the knowledge about the various thermal methods like TGA, DTA, DSC and their applications.
UNIT-I	**Data Analysis** **[10 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), Standard reference materials and procedures, standard and official methods.
UNIT-II	**Titrimetric Methods of Analysis** **[10 L]** Standard solutions, indicators, theory of indicators, types of titrations; acid-base, precipitation, redox, complexometric, conductometric and potentiometric titration, theory of acid base indicators, Mohr, Volhard and Fajans methods, EDTA based titration, redox indicators and their use in volumetric analysis, iodometry and iodimetry.
UNIT-III	**Electroanalytical Methods of Analysis** **[10 L]** **Voltammetry and Polarography**

	General principles, excitation signals, instrumentation, voltammogram; Polarography; the dropping mercury electrode (DME) and potential range, limiting current, diffusion current & Ilkovic equation, factors affecting the diffusion current, normal and differential-pulse polarography, square-wave polarography; Cyclic voltammetry; Stripping voltammetry. **Potentiometry and Conductometry** General principles, liquid-junction potential, reference electrodes, pH meter, direct potentiometric measurements, potentiometric pH measurements with glass electrode and combination pH electrode, potentiometric titration. Conductometry Basic principles, instrumentation, conductance cells, conductometric titrations-acids of different pka values at various concentrations by strong and weak base, modifications for titration of weak acid, mixture of a strong and weak acid.
UNIT-IV	**Thermal and Calorimetric Methods of Analysis [10 L]** Thermogravimetric analysis, apparatus, methodology, application; differential thermal analysis, apparatus, methodology; derivative thermogravimetry, instrumentation, methodology; differential scanning calorimtry; instrumentation, methodology. Comparative study of TGA, DTA and DSC. Interpretation of TGA and DTA curves of important compounds e.g., calcium oxalate monohydrate, magnesium oxalate monohydrate. Analysis of silver-copper alloy and dolomite sample by TGA. Thermometric titrimetry and applications to acid-base and complexometric titrations.

Recommended Books:

1. J. Heyrovsky and K. Kuta, Principles of Polarography, 1st Edition (1966), Academic Press, New York.
2. I.M. Kolthoff and J.J. Lingane, Polarography, 2nd Edition (1952), Wiley Intersciences, New York.
3. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Principles of Instrumental Analysis, 5th Edition (1998), Saunders College Publishing, Philadelphia, London.
4. G. D. Christian, Analytical Chemistry, 5th Edition (1994), John Wiley & Sons, New York.
5. G.W. Ewing, Instrumental Methods of Chemical Analysis, 5th Edition (1978), McGraw Hill Books Co., New York.
6. D. Harvey, Modern Analytical Chemistry, McGraw Hill Higher Education, New York, 2ooo.
7. R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, Modern Methods of Chemical Analysis, 2nd Edition (1976), John Wiley, New York.
8. J.H. Kennedy, Analytical Chemistry: Principles, 2nd Edition (1990), Saunders Holt, London.

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Subject: Inorganic Chemistry Lab-I (Code-MCY-105P)	**Syllabus for M.Sc. -1st Semester (I Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	0	0	4

Course Objective	To gain Practical knowledge of Inorganic Chemistry.
Course Outcomes (COs)	To learn synthesis of Inorganic complexes and salts.
Exp.1	To Synthesize 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	To SynthesizeCopper(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	To Synthesize 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	To synthesize 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	To Synthesize 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	To estimate the percentage of Copper ions in a given solution by titration method.
Exp.7	To Synthesize 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	To synthesize 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	To synthesize Hexa amine Nickel-II chloride. Calculate the percentage yield and give the structure of the complex. Also write the chemical reactions involved.
Exp.10	To Synthesis Sodium trioxalato ferrate trihydrate. Calculate the percentage yield and give the structure of the complex. Also write the chemical reactions involved.

Recommended Books:

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

DEPARTMENT OF CHEMISTRY
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Subject: Organic Chemistry Lab-I (Code-MCY-106P)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	0	0	4

Course Objective	The course has been designed to enable the students to learn the organic chemistry practical's skills.
Course Outcomes (COs)	
CO1	To familiarize the students with the purification techniques.
CO2	To learn the fundamental ideas of separation and purification of organic compounds.
CO3	To impart the knowledge about the separation of a binary mixture of organic compounds.
CO4	To learn the 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. (Minimum three 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. (Minimum three exercises)
Exp.8-10	**Identification of the organic compounds** Identification of the organic compounds by systematic qualitative organic analysis. (Minimum three exercises)

Recommended Books:

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

3. Microscale and Macroscale Organic Experiments- K.L. Williamson (D.C. Heath and Co., 1989).
4. Vogel's Textbook of Practical Organic Chemistry, 5th ed.- A.R. Tatchell (ELBS, 1996)
5. Comprehensive Practical Organic Chemistry, V. K. Ahluwalia and Renu Aggarwal, (University Press-2000).

DEPARTMENT OF CHEMISTRY
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Subject: Physical Chemistry Lab-I (Code-MCY-107P)	**Syllabus for M.Sc.- 1st Semester (I Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	0	0	4

Course Objective	To develop the experimental skills by providing practical course dedicated to physical chemistry.
Course Outcomes (COs)	
CO1	To get the knowledge of coloumetric measurements.
CO2	To perform titrations using potentiometry, conductometry and pH-metry.
CO3	To acquire the knowledge about the surface tension measurements.
CO4	To study the rate of reaction.
S. No.	**Details of the Experiments**
Exp.1	Determination of strengths of halides in a mixture potentiometrically.
Exp.2	Determination of the strength of strong and weak acid in a given mixture conductometrically.
Exp.3	Determination of solubility and solubility product of sparingly soluble salt BaSO4.
Exp.4	Determine the pK1 and pK2 value of phosphoric acid by pH metry.
Exp.5	Determine the indicator constant of given indicator by colorimetric measurements.
Exp.6	To study the kinetics of mutarotation of glucose/fructose polarographically.
Exp.7	To study the effect of surfactants (sodium chloride) on surface tension of given liquid.
Exp.8	To determine the radius of molecule by viscosity measurements.
Exp.9	Study the effect of surfactant (n-propyl alcohol) at various concentrations on the surface tension of water.
Exp.10	Investigate the influence of ionic strength on the rate constant of the reaction between $K_2S_2O_8$ and KI.

Recommended Books:

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

DEPARTMENT OF CHEMISTRY
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Subject: Organic Reaction Mechanisms (Code-MCY-201)	**Syllabus for M.Sc. -2nd Semester (I Year)**		**Total Course Credit: 4**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	4	0	0

Course Objective	The course has been designed to enable the students to learn the organic reaction mechanisms.
Course Outcomes (COs)	
CO1	To familiarize the students with different organic reaction mechanisms in organic chemistry.
CO2	To learn various molecular rearrangements of synthetic importance.
CO3	To gain insight about advance organic synthesis on account of additions to multiple bonds.
CO4	To learn and understand the orbital interactions in concerted reactions. Learn to apply concerted and stepwise reactions in organic synthesis.
UNIT-I	**Aliphatic Nucleophilic Substitutions [10 L]** The SN2, SN1, mixed SN1 and SN2 and SET mechanisms. The neighbouring group mechanism, neighbouring group participation byπ and σ bonds, anchimeric assistance. The SNi mechanism. Nucleophilic substituon 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 Aromatic 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 Free Radical Substitution: Free radical substitution mechanisms. Mechanisms at aromatic substrate. Neighbouring group assistance in free radical reactions, Reactivity for aliphatic and aromatic substrates. Reactivity in the attacking radical. Effect of solvent on reactivity.

	Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts, Sandmeyer reaction, free radical rearrangements and Hunsdiecker reaction.
UNIT-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, Ene-reaction, Michael reaction and Sharpless assymetric epoxidation. 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.
UNIT-III	**Molecular Rearrangements** **[10 L]** General mechanistic treatment of nucleophilic, electrophilic and free radical rearrangments. 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.
UNIT-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. Advanced Organic Chemistry; Jerry March, Fourth edition, Wiley & Sons, (2007).
2. Advanced Organic Chemistry 4th Ed. - F. A. Carey and R. J. Sundberg. (Plenum, 2001).

3. A Guide Book to Mechanism in Organic Chemistry 6th Ed.- Peter Sykes. (Longman, 1996).
4. Structure and Mechanism in Organic Chemistry 2nd Ed. - C. K. Ingold. (CBS, 1994).
5. Modern Organic Reactions 2nd Ed. - H.O. House (Benjamin, 1972)
6. Principles of Organic Synthesis 2nd Ed. - R.O.C. Norman (Chapmann Hall, 1978)
7. Reaction Mechanism in Organic Chemistry 3rd Ed. - S.M. Mykherjee and S.P. Singh. Macmillan, 1998).
8. Organic Chemistry - J. Hornback,pk. (Brooks/Cole, 1998).
9. Fleming, I. Pericyclic reactions, Oxford science publication (1998)
10. S.M. Mukherjee and S.P. Singh, Pericyclic Reactions, MacMillan India, New Delhi.
11. Organic Chemistry, 5th Ed.- John McMurry. (Brooks/Cole, 2000) .
12. Kurti, L. and Czako, B. Strategic applications of Named reactions, in organic synthesis(2004).
13. Carruthers, W. and Coldham, I. Modern methods of organic synthesis, Cambridge University Press(2004).
14. G. S. Zweifel and M. H. Nantz, Modern Organic Synthesis- An Introduction, W. H. Freemanand Company,2006

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Coordination Chemistry, Organometallics & Group Theory (Code-MCY-202)	**Syllabus for M.Sc.- 2nd Semester (I Year)**		**Total Course Credit: 4**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	4	0	0

Course Objective	To introduce the students to the reactions, magnetism and spectra of coordination compounds. Mechanistic aspects of several well-known industrial catalytic techniques will be studied. To understand the symmetry properties of molecules and application of group theory in understanding the molecular properties based on symmetry.
Course Outcomes (COs)	
CO1	To learn about the reactions, electronic spectra and magnetism of coordination compounds.
CO2	To learn and understand the bonding principles and reaction mechanism in organometallic chemistry.
CO3	To understand the industrially important homogenous catalysis cycles.
CO4	To apply group theory and character table to analyze the molecular properties.
UNIT-I	**Coordination Chemistry-II [10 L]** 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, Jahn teller distortions and spectra, Charge Transfer spectra, Magnetism: Definition of magnetic properties, Curie and Curie-Weiss Law, Orbital and spin contribution to magnetic susceptibility, Introduction to magnetic properties of lanthanides, Magnetic exchange coupling, Spin cross over phenomena.
UNIT-II	**Coordination Chemistry-III [10 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.
UNIT-III	**Organometallic Chemistry-II** **[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 Polymerisation and water gas reaction.
UNIT-IV	**Symmetry and Group theory** **[10 L]** Symmetry elements and operations, Combination of symmetry operations, Groups, Subgroups, Classes, Group multiplication tables, Symmetry point groups, Identification of point groups, Systematic procedure for assignment of point groups to molecules, Symmetry classes and their geometrical significance reducible, Representations and Irreducible representations, Great orthogonally theorem (GOT), Applications of GOT, Character table (C_{2V}, C_{3V}, C_{2h}).

Recommended Books:

1. Inorganic Chemistry, James E. Huheey, Pearson. 4th Edn.
2. Inorganic Chemistry, Gary L. Miessler, Donald A. Tarr, Pearson, 3rd Edn.
3. Inorganic Chemistry, F.A. Cotton, Wiley, 6th Edn.
4. Inorganic Chemistry, Weller and Armstrong, Oxford, 6th Edn.
5. Inoragnic Chemistry, J. D. Lee, Wiley, 5thEdn.
6. Organometallic Chemistry, B.D. Gupta & A.J. Elias, University Press, 2nd Edn.
7. Chemical Applications of Group Theory, F. Albert Cotton, John Wiley & Sons, 2008, 3rd Edn.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Surface and Solid-State Chemistry (Code-MCY-203)	**Syllabus for M.Sc.-2nd Semester (I Year)**		**Total Course Credit: 4**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	3	1	0

Course Objective	The course has been designed to enable the students to learn the surface chemistry and solid state chemistry.
Course Outcomes(COs)	
CO1	To understand the phenomena of surface chemistry.
CO2	To learn about the solid state chemistry.
CO3	To gain knowledge about different properties of solids.
CO4	To acquire the knowledge of semiconductors and their devices.
UNIT-I	**Surface Chemistry** **[10 L]** Adsorption by Solids and Gases, Factors Influencing, Adsorption, Freundlich Adsorption Isotherm, Langmuir Theory of Adsorption, BET Theory of Multilayer Adsorption, Derivation of BET Equation, Types of Adsorption Isotherm
UNIT-II	**Solid State Chemistry** **[10 L]** Miller indices; Bragg equation, Debye-Scherrer method of X-ray structural analysis of crystals, identification of cubic unit cells from systematic absences in diffraction pattern.Classification of solids, Crystal lattice and Unit cell, Close packed structures, Packing efficiency, packing in ionic solids, atomic packing factor in crystal structures, ionic radius, radius ratio rule, (3, 4, 6, 8 coordinate structures). Octahedral and tetrahedral voids, isomorphism and polymorphism, numericals. Unit cell dimensions numericals. Imperfections in Solids: Perfect and imperfect crystal, point defects, stoichiometric defects, Schootky & Frankle defects, thermodynamics of their formation, colour centers, Non-stoichiometric defects, metal excess and metal deficiency defects, line imperfections, Edge dislocation, Screw dislocation, Burgers circuits, Surface imperfections, grain boundaries & stacking faults.
UNIT-III	**Properties of Solids** **[10 L]**

	Electrical Properties: Thermoelectric effects, Thomson effects, Peltier effect, Seebeck effect, thermocouples, Hall Effect, Dielectric materials, Ferro, Pyro, Piezo electricity and their relations. Applications. Magnetic Properties: Dielectric Constant, Polarization andPolarizability, Piezoelectricity, Pyroelectricity and Ferroelectricity, Ferroelectric Materials and Their Applications, Effect of Temperature, Magnetic Domains and Hysteresis. Optical Properties: Luminescence and Phosphors, Lasers, Photoconduction, Photoelectric effects.
UNIT-IV	**Semiconductors and their Devices** **[10 L]** Free electron theory, Conduction by free electrons, Band theory, Refinement to simple band theory, Band structure of metals, Intrinsic and extrinsic semiconductors, semiconductors materials and their fabrication, semiconductors devices p-n junctions, properties of p-n junctions, semiconductors diode as rectifier, Filters circuits, Zener diode as a voltage stabilizer, transistors transistor as an amplifier Super conductivity: conventional super conductors, organic super conductors (organic metals), fullerene, high temperature super conductors, organic charge transfer complexes Applications.

Recommended Books:

1. Principles of Physical Chemistry: Puri, Sharma, Pathania, Latest Edition
2. Text Book of Physical Chemistry - S. Glasstone (McMillan), Latest Edition
3. Modern Electrochemistry, Vol 1, 2A and 2B, John O" M Bokris, Latest Edition
4. An Introduction to Electrochemistry, Samuel Glasstone,Latest Edition
5. Theoretical Electrochemistry, L.Antropov. Latest Edition
6. Advanced Physical Chemistry, Gurtu and Gurtu. Latest Edition

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Chromatographic Techniques (Code-MCY-204)	**Syllabus for M.Sc.-2nd Semester (I Year)**		**Total Course Credit: 4**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	4	0	0

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)	
CO1	To understand the basic concepts of chromatography and their related terms.
CO2	To learn about the column chromatography like Gas chromatography and high performance liquid chromatography.
CO3	To gain knowledge about ion-exchange chromatography and size exclusion chromatography.
CO4	To acquire the knowledge of super critical fluid chromatography and extraction process.
UNIT-I	**Chromatography [10 L]** Introduction, principle of chromatography, classification of chromatographic methods; techniques of planar and column chromatography; paper chromatography, types of paper chromatography, experimental details for qualitative and quantitative analysis, applications, Thin-layer chromatography; scope; procedure; thin-layer plates and stationary phases; mobile phase; plate development; detection of the spots; performance characteristics of thin-layer plates-retardation and retention factor, plate heights; high-performance thin-layer chromatography; qualitative applications variables that influence Rf, elution methods, quantitative measurements.
UNIT-II	**Gas Chromatography [10 L]** Principles; instruments; carrier gases; columns and stationary phases; sample injection systems, detectors-characteristics of the ideal detectors, thermal conductivity detector, flame ionization detector, electron capture detector and others, factors affecting the efficiency of the column, qualitative analysis, Kovats

	retention index I, quantitative analysis, analyses based on peak height and peak areas, temperature programming; applications. **High Performance Liquid Chromatography;** Principles, instrumentations; isocratic and gradient elution, pumping systems, columns and column packings, detectors-absorbance, fluorescence, refractive-index and electrochemical detectors, basic difference between HPLC and conventional liquid chromatography, advantages and applications. **Hyphenated Techniques** An overview of hyphenated techniques viz. GC-MS, HPLC-MS, HPTLC-MS and their applications.
UNIT-III	**Ion-Exchange/Ion Chromatography [10 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. **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.
UNIT-IV	**Super Critical Fluid Chromatography and Extraction [10 L]** Super critical fluids and its properties, principle, instrumentation, stationary and mobile phases, detectors, operating variables, comparisons with other types of chromatography, applications, super critical fluid extraction, choice of super critical fluids, advantages, applications.

Recommended Books:

1. James M. Miller, Chromatography: Concepts and Contrasts, 2ndEd., Wiley, 2009.
2. O David Sparkman, Zelda Penton and Fulton G. Kitson, Gas Chromatography and Mass Spectrometry:A Practical Guide, 2ndEd., Elsevier, 2011.
3. Veronika R. Meyer, Practical High-Performance Liquid Chromatography, 5thEd., Wiley, 2010.
4. Raymond P.W. Scott, Chromatography Theory-Chromatographic Science, 88, Jack Cazes, CRC Press; 2002.
5. Robert L. Grob & Eugene F. Barry, Modern Practice of Gas Chromatography, 4thEd., John Wiley & Sons, 2004.
6. Gary D. Christian, Analytical Chemistry, 6thEd., Wiley, 2003.

7. Douglas A. Skoog, F. James Holler, Instrumental Analysis, 2nd Indian Reprint, Stanley R. Crouch, Brooks Cole-Cenage Learning 2008.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Inorganic Chemistry Lab-II (Code-MCY-205P)	**Syllabus for M.Sc.- 2nd Semester (I Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	0	0	4

Course Objective	To gain practical knowledge of Inorganic Chemistry.
Course Outcomes (COs)	To learn synthesis of Inorganic complexes and salts.
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	Determination of the amount of (Fe^{2+}) in the given sample spectrophotometrically using 1,10-phenanthroline.
Exp.6	Determination of the amount of (Mn^{2+}) ion in the given sample spectrometrically.
Exp.7	Determination of the concentration of phosphate (PO_4^{3-}) in potassium dihydrogen phosphate (KH_2PO_4) by spectrophotometer.
Exp.8	Synthesis of tris (ethylenediamine) cobalt (III) chloride.
Exp.9	Synthesis of Mercurytetrathiocyanatocobaltate (II).
Exp.10	Synthesis of Ammonium dodecamolbedophosphate.

Recommended Books:

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

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Organic Chemistry Lab-II (Code-MCY-206P)	**Syllabus for M.Sc. -2nd Semester (I Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	0	0	4

Course Objective	The course has been designed to enable the students to learn the organic chemistry practical's skills.
Course Outcomes (COs)	
CO1	To familiarize the students with the purification techniques.
CO2	To learn the fundamental ideas of separation and purification of organic compounds.
CO3	To impart the knowledge about the separation of a binary mixture of organic compounds.
CO4	To learn the qualitative analysis 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 5. Glucazone from glucose 6. Benzoin to Benzil to Benzilic Acid
Exp.5-6	**Isolation of;** 1. caffeine from tealeaves 2. Lycopene from tomatoes. 3. Casein from milk
Exp.7-8	**Detection of functional groups** Detection of functional groups using IR spectroscopy in a given organic compound (spectra to be provided). Minimum two exercises.
Exp.9-10	**Calculation of λmax**

	Calculation of λmax for a given organic compound using UV-Vis spectrophotometer. (Spectra to be provided). Minimum two exercises.

Recommended Books:

1. Advanced Practical Organic Chemistry, 2nd ed. - N.K. Vishnoi (Vikas, 1999).
2. Experiments and Techniques in Organic Chemistry - D. Pasto, C. Johnson and M. Miller (Prentice-hall, 1992.)
3. Microscale and Macroscale Organic Experiments- K.L. Williamson (D.C. Heath and Co., 1989).
4. Vogel's Textbook of Practical Organic Chemistry, 5th ed.- A.R. Tatchell (ELBS, 1996)
5. Comprehensive Practical Organic Chemistry, V. K. Ahluwalia and Renu Aggarwal, (University Press-2000)

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Physical Chemistry Lab-II (Code-MCY-207P)	**Syllabus for M.Sc.- 2nd Semester (I Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	0	0	4

Course Objective	To develop the experimental skills by providing the practical course dedicated to the physical chemistry.
Course Outcomes (COs)	
CO1	To get the knowledge of adsorption phenomena.
CO2	To perform titrations using potentiometry, conductometry and pH-metry.
CO3	To acquire the knowledge about the dissociation constsnat.
CO4	To study the variation in viscosity of the mixture.
S. No.	**Details of the Experiments**
Exp.1	To study the adsorption of acetic acid from aqueous solution by activated charcoal and examine the validity of Freundlich and Langmuir's isotherm.
Exp.2	Investigate the adsorption of acetic / oxalic acid by activated charcoal and test the validity of Freundlich and Langmuir's isotherm.
Exp.3	To study auto catalysis reaction between potassium permanganate and oxalic acid.
Exp.4	Determination of acidic and basic dissociation constants of an amino acid and its isoelectric point.
Exp.5	To study the variation of viscosity with the composition of mixtures (ethanol-water-HNO_3-chloroform) and to determine the formation of complex between two liquids.
Exp.6	Titrate potentiometrically phosphoric acid solution against NaOH and calculate pK1, pK2 and pK3 of the acid.
Exp.7	To determine the hydrolysis constant of aniline hydrochloride by pH measurements.
Exp.8	Determine the amount of trichloroacetic acid, monoacetic acid and acetic acid in a given solution by conductometric titration against sodium hydroxide solution.
Exp.9	Determination of dissociation constants of phosphoric acid potentiometrically.
Exp.10	Determination of dissociation constants of weak acid potentiometrically.

Recommended Books:

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

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Organic Spectroscopy and Modern Organic Synthesis (Code-MCY-301)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 4**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	4	0	0

Course Objective	The course has been designed to enable the students to learn the organic spectroscopy and modern organic synthesis.
Course Outcomes (COs)	
CO1	To familiarize the students with the organic structure determination methods involving spectroscopy.
CO2	To learn the fundamental ideas of photochemical excitation/deexcitation events, and the molecular events that can intervene at different levels and their applications.
CO3	To impart the knowledge of modern synthetic methods used in functional group transformations.
CO4	To learn retrosynthetic approach in the art of modern organic synthesis.
UNIT-I	**UV, IR Spectroscopy and Mass Spectrometry [10 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.
UNIT-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 A2, AB, AX, AB2, AX2, A2B2. Proton exchange, deuterium exchange, Peak broadening exchange C-13 NMR: Carbon 13-chemical shifts, proton coupled and decoupled spectra. Nuclear overhouser, Effect, Off-Resonance De-coupling, A quick dip in to DEPT-45 , DEPT-90, DEPT-135. Introduction to two-dimensional spectroscopy methods, COSY techniques, HETCOR technique, NOESY, combined structure problems.
UNIT-III	**Photochemistry [10 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. Quantum yield. Types of photochemical reactions. Photochemistry of alkenes: Geometrical isomerisations, cyclisation and dimerisation 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 processess). Intermolecular cycloaddition reactions (Paterno- Buchi reaction). Photochemistry of unsaturated carbonyl compounds: Photochemical reactions of α, β-unsaturated carbonyl compounds. (H-Abstraction and isomerisation to β, γ-unsaturated carbonyl compounds). Photolysis of cyclic α, β- unsaturated ketones (dimerisation and lumiketone rearrangement) and cyclohexadienones.
UNIT-IV	**Designing Organic Synthesis [10 L]** Retrosynthetic analysis: Basic principles and terminology of retrosynthesis, guidelines, synthesis of aromatic compounds, one group and two group C-X disconnections, one group C-C and two group C-C disconnections, amine and alkene synthesis, important strategies of retrosynthesis, functional group transposition, important functional group interconversions, reversal of polarity (umpolung). Protection and deprotection of functional groups: Protection and deprotection of hydroxy, carboxyl, carbonyl, carboxy amino groups and carbon-carbon multiple bonds, chemo- and regioselective protection and deprotection, illustration of protection and deprotection in multi-step synthesis.

Recommended Books:

1. Spectrometric identification of Organic Compounds. 5th Ed., R.M.Silverstein, G. C. Bassler and T.C.Morill. (Jhon Wiley-1991).
2. Introduction to NMR Spectroscopy, R.J.Abraham. J.Fisher and P.Loftus (Wiley-1991)
3. Applications of absorption spectroscopy of Organic Compounds, J.R.Dyer (Prentice Hall-1991).
4. Spectroscopic Methods in organic Chemistry, D.H.Williams; I.Fleming (Tata- McGraw Hill-1988).
5. Intoductory Photochemistry, A.Cox and T.Kemp (McGraw Hall-1971).
6. Organic Photochemistry, 2nd Ed., J.Coxon, and B.Halton (2nd Ed. Cambridge University press-1987).
7. Fundamentals of photochemistry, Rohtagi & Mukherjee (Wiley Eastern-1992).
8. Kemp, W, Organic Spectroscopy, W.H. Freeman & Co.
9. D. H. Williams, I. Fleming, Spectroscopic Methods in Organic Chemistry, Tata McGrawHill.
10. Carey, F. A. and Sundberg, R. J., "Advanced Organic Chemistry, Part B: Reactions and Synthesis", 5th Ed., Springer, 2007.
11. Smith, M.B., "Organic Synthesis", 3rd Ed., Academic Press, 2010.
12. Peter Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman Ltd., New Delhi.

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Bio-inorganic & Nanotechnology (Code-MCY-302)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 4**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	4	0	0

Course Objective	The course aims at a detailed understanding of bio-inorganic chemistry of metals and their actions. 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)	
CO1	Understanding of Bioinorganic Chemistry of elements.
CO2	To learn the different biochemical reactions that occurs in living systems.
CO3	To describe important physical methods and structures in the field of nanoscience.
CO4	To familiarize the students with the applications of nanotechnology.
UNIT-I	**Metal ions in Biochemical Systems [10 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).
UNIT-II	**Metalloporphyrins, Respiration and Electron Transport in Biosystems [10 L]** Metalloporphyrins, Cytochromes (Cytochromes C, Cytochrome C-oxidase, Cytochrome P-450). Dioxygen transport (haemocyanin and hemoerythrin), Structure and physiological role of hemoglobin and myoglobin, Bohr Effect and cooperativity, Chloride effect, Iron-Sulfur proteins, Ferredoxins, Rubredoxin, Copper proteins, Photosynthesis (PS I and PS II), Z-scheme, Structure of chlorophyll a and b, Superoxide dismutase-A.
UNIT-III	**Enzymes and medicinal Chemistry [10 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.
UNIT-IV	**An Introduction to Nanotechnology [10 L]** Fundamentals of nanotechnology, introduction to nano-scale, nanocomposites, thin films, nano-foam, Advanced Inorganic materials, Nanotechnology & its industrial application, potential application of inorganic nanomaterials. 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.

Recommended Books:

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

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Advanced Physical Chemistry (Code-MCY-303)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 4**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	3	1	0

Course Objective	The course has been designed to enable the students to learn the advanced physical chemistry.
Course Outcomes (COs)	
CO1	To acquire the knowledge about the quantum chemistry.
CO2	To gain knowledge about the molecular orbital theory of conjugates systems.
CO3	To study the advanced statistical thermodynamics.
CO4	To learn about the irreversible thermodynamics.
UNIT-I	**Quantum Chemistry-I [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.
UNIT-II	**Quantum Chemistry-II [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.
UNIT-III	**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.
UNIT-IV	**Irreversible Thermodynamics [10 L]** Postulates, entropy production in heat, entropy production in matter flow, entropy production in chemical reactions, Onsager's theory, microscopic reversibility and Onsager's reciprocity, stationary states and entropy production, Prigogine's principle of minimum entropy, application to thermoelectric effects-Seebeck and Peltier effect.

Recommended Books:

1. Quantum Chemistry: Ira N. Levine, Latest Edition
2. Quantum Chemistry: R.K. Prasad, Latest Edition
3. Quantum Chemistry: B.K. Sen, Latest Edition
4. Principles of Physical Chemistry: Puri, Sharma, Pathania, Latest Edition
5. Advanced Physical Chemistry: Gurdeep - Raj, Plenum. Latest Edition
6. Physical Chemistry: Peter Atkins, Latest Edition
7. Modern Quantum Chemistry, A. Szabo and N.L. Ostlund, Dover, New York (1996), Latest Edition
8. Approximate Molecular Orbital Theory, J. A. Pople and D. L. Beveridge, McGraw Hill, New York, Latest Edition
9. Thermodynamics for Chemists - S. Glasstone (EWP, New Delhi), Latest Edition
10. Statistical Thermodynamics, Donaid A. Mc Qurrie, Harper & Row, New York 1973, Latest Edition
11. Statistical Thermodynamics, M.C. Gupta, Wiley Eastern Ltd. New Delhi, Latest Edition
12. Elements of Statistical Thermodynamics, L. K. Nash Addison Wesley, Menlo Park, 1972, Latest Edition
13. Non-Equilibrium Thermodynamics, Prigogine Kalyani Publication, Latest Edition
14. Thermodynamics and Non-Equilibrium Thermodynamics, Gurudeep & Raj, Latest Edition

DEPARTMENT OF CHEMISTRY
NATIONAL INSTITUTE OF TECHNOLOGY, SRINAGAR

Subject: Advanced Instrumentation Techniques (Code-MCY-304)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 4**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	4	0	0

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)	
CO1	To acquire the knowledge about the spectroscopic techniques like AAS, AES, XRD and XRF.
CO2	To gain knowledge about the molecular spectroscopy techniques like fluorescence, phosphorescence, chemiluminescence.
CO3	To study the advanced electron spectroscopy like XPS, AES etc.
CO4	To learn about the advanced electron microscopy like SEM/TEM.
UNIT-I	**Atomic Spectroscopy [10 L]** Origins of atomic spectra, production of atoms and ions, Atomic emission spectrometry (AES), Atomic absorption spectroscopy (AAS), Atomic fluorescence spectrometry (AFS), Atomic mass spectrometry (AMS); principle, instrumentations, working, applications. **X-ray Methods of Analysis** Principle, theory, instrumentation and applications of X-rays (emission, absorption, diffraction and fluorescence methods), Absorptive apparatus: chemical analysis using X-ray absorption, X-ray Diffraction; Chemical analysis with X-ray diffraction, numerical problems, X-ray Fluorescence; instrumentation and chemical analysis.
UNIT-II	**Molecular Spectroscopy [10 L]** UV-visible molecular absorption spectrometry; principle, instrumentation and application, Molecular fluorescence spectroscopy; theory of molecular fluorescence, effect of concentration on fluorescence intensity, fluorescence instruments, application of fluorescence methods, Molecular phosphorescence

	spectroscopy, chemiluminescence methods; principle, instrumentation and their applications.
UNIT-III	**Electron Spectroscopy [10 L]** Definition of a solid surface, Types of surface measurements; X-Ray photoelectron spectroscopy (XPS/ESCA): Introduction, 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-quantitative analysis.
UNIT-IV	**Electron Microscopy [10 L]** Scanning electron microscopy (SEM); basics, instrumentation, applications. Transmission electron microscopy (TEM); Introduction, basic theory, electron gun, electromagnetic lenses, imaging, operating parameters-magnification, resolution, depth of field; sample preparation, specimen orientation and manipulation; applications; selected area electron diffraction.

Recommended Books:

1. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Principles of Instrumental Analysis, 5th Edition (1998), Saunders College Publishing, Philadelphia, London.
2. G. D. Christian, Analytical Chemistry, 5th Edition (1994), John Wiley & Sons, New York.
3. G.W. Ewing, Instrumental Methods of Chemical Analysis, 5th Edition (1978), McGraw Hill Books Co., New York.
4. R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, Modern Methods of Chemical Analysis, 2nd Edition (1976), John Wiley, New York.
5. J.H. Kennedy, Analytical Chemistry: Principles, 2nd Edition (1990), Saunders Holt, London
6. J.M. Hollas, Modern Spectroscopy, 3rd Edition (1996), John Wiley, New York.

DEPARTMENT OF CHEMISTRY
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Subject: Analytical Chemistry Lab (Code-MCY-305P)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	0	0	4

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)	
CO1	To get the knowledge of solvent extraction using Soxhlet apparatus and its applications.
CO2	To perform titrations using potentiometry, conductometry and pH-metry.
CO3	To acquire the knowledge about the chromatographic separation to identify the mixture's components and their quantification.
CO4	To study the thermograms using TG/DTA method.
S. No.	**Details of the Experiments**
Exp.1	Extraction of oils from ground nuts using Soxhlet apparatus (Solid-Liquid extraction).
Exp.2	Determination of saponification value/Iodine value of an oil sample.
Exp.3	Determination of dissociation constant of an amino acid and hence the isoelectric point of the acid.
Exp.4	Determination of Cd^{2+} ions concentration in given solution polarographically.
Exp.5	Determination of ferrous ammonium sulphate potentiometrically with standard ceric sulphate solution (Direct and back titration).
Exp.6	To determine the strength of strong and weak acids in a given mixture conductometrically.
Exp.7	Spectrophotometric determination (in ppm) of Fe (II) or Fe (III) using 1,10 Phenanthroline (or thiocyanate) as colorimetric reagent.
Exp.8	To separate the mixture of amino acids using thin layer chromatography.
Exp.9	Analysis of Paracetamol by HPLC technique.

Exp.10	Estimation of Ca and Mg from the mixture of oxalate by recording their TGA curve

Recommended Books:

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

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Subject: Computational Methods in Chemistry Lab (Code-MCY-306P)	**Syllabus for M.Sc.- 3rd Semester (II Year)**		**Total Course Credit: 2**		
Mid-Term	Class Assessment	Final-Term	L	T	P
30 (Marks)	10 (Marks)	60 (Marks)	0	0	4

Course Objective	The programs objective map to working knowledge of computers and graphics to address needs in chemistry and related areas.
Course Outcomes (COs)	
CO1	To formulate molecular representations and communication skills like drawing and writing structures and formulas using Microsoft Excel worksheet.
CO2	To draw bonding and structure models using ChemDraw software.
CO3	To draw FTIR spectra, Chromatograms and Thermograms using Origin software.
CO4	To study the parameters of molecules using ChemDraw/Origin software.
Exp. 1	To write chemistry formulae/composition and their calculation parameters using Microsoft Excel worksheet.
Exp. 2	To write statistical and mathematical equations and formulae in chemistry using of Mathtype software.
Exp. 3	To determine the value of correlation coefficient using Microsoft Excel worksheet.
Exp. 4	To determine the value of correlation coefficient using Origin software.
Exp. 5	To draw the FTIR spectrum/Gas Chromatogram/thermogram of chemical substance using Origin software.
Exp. 6	To draw linear and parabolic graphs using Origin software.
Exp. 7	To draw the structures of complex aliphatic molecules using ChemDraw software.
Exp. 8	To draw the structures of complex aromatic molecules using ChemDraw software.
Exp. 9	Determination of molecular formula, molecular weight and elemental percentage of chemical structures using ChemDraw software.
Exp. 10	Preparation of research proposal using MS Word/MS Power Point Presentation.

Recommended Books:

1. MS Office made easy, supplied by Microsoft Inc.
2. Curtin, Fuley Sen and Morin, Information Technology-The breaking wave, TMH 1999.
3. Norris, A.C. Computational Chemistry, 1st edition, John Wiley & Sons, 1981.
5. Origin Software latest version.
6. ChemDraw Software latest version.