SU : PROPOSED SYLLABUS OF M.Sc. CHEMISTRY

PART -1

First Semester (CBCS)

Course Code	Course Type	Course (Paper/Subjects)	Credits	Contact Hours Per WeeK			EoSE Duration (Hrs.)		Marks	
				L	T	P	Thy	P	SEE	IA
MSC 101	CCC	INORGANIC CHEMISTRY-I	6	4	3	00	3	0	70	30
MSC 102	CCC	ORGANIC CHEMISTRY-I	6	4	3	00	3	0	70	30
MSC 103	CCC	PHYSICAL CHEMISTRY-I	6	4	3	00	3	0	70	30
MSC 104	CCC	THEORY AND APPLICATION OF SPECTROSCOPY-I	6	4	3	00	3	0	70	30
MSC 105	CCC	LAB COURSE- I	6	0	0	09	0		100	
MSC 106	CCC	LAB COURSE- II	6	0	0	09	0		100	
MINIMUM CREDITS IN INDIVIDUAL SUBJECT IS 6 AND IN COMPLETE SEMESTER IT WOULD BE 36			Total Credit = 36							

M.Sc. CHEMISTRY FIRST SEMESTER			
COURSE CODE: MSC 101		**COURSE TYPE: CCC**	
COURSE TITLE: **INORGANIC CHEMISTRY-1**			
CREDIT: **THEORY:** **6**	**PRACTICAL:**	**HOURS:** **THEORY:** **90**	**PRACTICAL:** **00**
MARKS: **THEORY:** **70+30**	**PRACTICAL:**	**MARKS** **THEORY:**	**PRACTICAL:**

OBJECTIVE:

Discussion of group theory impart various symmetry dependent spectroscopic features of transition metal complexes. To develop the understanding of evolution of bonding theories in transition metal complexes and their role to rationalize various physical phenomena including magnetic and spectral properties. Discussion of Metal Ligand equilibria in solution.

UNIT-1 22 Hours

SYMMETRY AND GROUP THEORY IN CHEMISTRY:

Symmetry elements and symmetry operation- Centre of Symmetry- Plane and its types of Symmetry-Proper and Improper axis of Symmetry- Principal axis and subsidiary axes- The concept of groups- Assigning Point groups with illustrative examples- Symmetry operations and order of a group - Group theoretical rules (Group postulates) - Reducible and Irreducible representations- Matrix representations of symmetry operations. Definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Point symmetry group. Schoen flies symbols, representations of groups by matrices (representation for the Cn, Cnv, Cnh, Dnh etc. groups to be worked out explicitly). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables of C2v, C2h, C3v and their use in spectroscopy.

UNIT-2 18 Hours

METAL-LIGAND BONDING IN TRANSITION METAL COMPLEXES:

Warner's theory, Valence Bond theory, Crystal field theory, calculation of CFSE and pairing energy, factors affecting CFSE, splitting diagrams in complexes of tetrahedral and square planar complexes; Jahn-Teller distortions; Spectrochemical series; Consequences of CFSE-thermodynamic and structural effects; site selection in spinels, experimental evidence for metal-ligand orbital overlap; ligand field theory, Nephelauxetic series, molecular orbital theory as applied to metal complexes. Brief introduction to Angular Overlap Model.

UNIT-3 14 Hours

ELECTRONIC SPECTRA OF TRANSITION METAL COMPLEXES:

Spectroscopic ground states; Orgel energy level and Tanabe-Sugano diagrams for transition metal complexes; Charge transfer spectra; electronic spectra of octahedral and tetrahedral Co(II) and Ni(II) complexes and calculation of ligand-field parameters.

UNIT-4 16 Hours

MAGNETIC PROPERTIES OF METAL COMPLEXES:

Magnetization, Intensity of magnetization, Molar magnetic susceptibility, Type of magnetism, Curie law, variation of magnetic moment with temperature (spin crossover), Spin and Orbital contributions to the magnetic moment.

UNIT-5 20 Hours

METAL LIGAND EQUILIBRIA IN SOLUTION:

Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH- metry and spectrophotometry

SUGGESTED READING BOOKS

1. Inorganic Chemistry by Gary L. Miessler, Paul J. Fischer, Donald A. Tarr.
2. Inorganic Chemistry by James E House.
3. Inorganic Chemistry (3rd Edition) by Catherine Housecroft, Alan G. Sharpe.
4. Inorganic Chemistry: Principles of Structure and Reactivity, by James E. Huheey, Ellen A. Keiter, et al.
5. F.A. Cotton and G. Wilkinson Advanced Inorganic Chemistry, 6th Edn. (1999), John Wiley & Sons, New York.
6. R. S. Drago, Physical Methods in Inorganic Chemistry, International Edn. (1971), Affiliated East-West Press, New Delhi.
7. Keith F. Purcell and John C. Kotz, Inorganic Chemistry, W. B. Sauders Com. (1987), Hong Kong.
8. K. Veera Reddy, Symmetry and Spectroscopy of Molecules, New Age International Pvt. Ltd., New Delhi (1999).
9. B.N. Figgis, Introduction to Ligand Fields, Wiley Eastern Ltd. New Delhi (1976).

M.Sc. CHEMISTRY FIRST SEMESTER			
COURSE CODE: MSC 102			**COURSE TYPE: CCC**
COURSE TITLE: **ORGANIC CHEMISTRY-I**			
CREDIT: **THEORY: 6**	**PRACTICAL:**	**HOURS:** **THEORY: 90**	**PRACTICAL:00**
MARKS: **THEORY:** **70+30**	**PRACTICAL:**	**MARKS** **THEORY:**	**PRACTICAL:**

OBJECTIVE:

To understand the concept of aromaticity and properties of aromatic compounds. Basic knowledge of Nucleophile, properties and mechanism of substitution reactions. Understanding of neighbouring group participation in organic synthesis and how it plays role in organic reactions. Basic ideas of generation of various reactive intermediates and role in organic synthesis. To explain the basic concepts, importance, and applications of asymmetric synthesis.

UNIT-1 15 Hours

AROMATICITY:

Benzenoid and non-benzenoid systems, antiaromaticity, homo-aromaticity, alternant, and non-alternant hydrocarbons.

UNIT-2 22 Hours

NUCLEOPHILIC SUBSTITUTION AT SATURATED CARBON:

Mechanism and Stereochemistry of SN1, SN2, SNi and SN2' reactions. Reactivity: The effect of substrate structure, attacking nucleophile, leaving group and reaction medium. Phase transfer catalysis and ultrasound, Ambient nucleophiles: Regioselectivity. Competition between SN1 and SN2 mechanisms.

UNIT-3 16 Hours

NEIGHBOURING GROUP PARTICIPATION:

Evidence of N.G.P.; the phenonium ion, participation by π and σ bonds, Anchimeric assistance. Classical versus non-classical carbonium ions–the present status.

UNIT-4 22 Hours

REACTIVE INTERMEDIATES:

Carbocations: Classical and non-classical, neighboring group participation, ion-pairs, molecular rearrangements in acyclic, monocyclic, and bicyclic systems, stability and reactivity of bridgehead carbocations. Carbanions: Generation, structure, and stability, ambident ions and their general reactions; HSAB principle and its applications. Free Radicals: Generation, structure, stability and reactions, cage effects; radical cations & radical anions, SRN1 mechanisms. Carbenes: Formation and structure, reactions involving carbenes and carbenoids. Nitrenes: Generation, structures, and reactions of nitrenes.

UNIT-5 15 Hours

ASYMMETRIC SYNTHESIS:

The chiral pool, chiral auxiliaries, enantiomeric excess, chiral catalysts, and reagents.

SUGGESTED READING BOOKS

1. Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2001.
2. M.B. Smith & Jerry March, March's Advanced Organic Chemistry, 5th Edition (2001), John Wiley & Sons, New York.
3. Peter Sykes, A Guidebook to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman Ltd., New Delhi.
4. S. M. Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, Ist Edition (1990), Macmillan India Ltd., New Delhi.
5. T.H. Lowry and K.S. Richardson, Mechanism and Theory in Organic Chemistry, 3rd Edition (1998), Addison – Wesley Longman Inc. (IS Edition)
6. G. S. Zweifel and M. H. Nantz, Modern Organic Synthesis, (2007), Freeman and Company, New York.
7. M. S. Singh, Advanced Organic Chemistry: Reactions and Mechanism: Pearson Education (Singapore) Pte. Ltd. (2005)

M.Sc. CHEMISTRY FIRST SEMESTER			
COURSE CODE: MSC 103		**COURSE TYPE: CCC**	
COURSE TITLE: **PHYSICAL CHEMISTRY I**			
CREDIT: **THEORY: 6**	**PRACTICAL:**	**HOURS:** **THEORY: 90**	**PRACTICAL: 00**
MARKS: **THEORY: 70+30**	**PRACTICAL:**	**MARKS** **THEORY:**	**PRACTICAL:**

OBJECTIVE:

To develop the concept of mathematics in quantum chemistry and basics of quantum chemistry. Understand basics of thermodynamics. To understand Debye Huckel theory, thermodynamics of electrified interface. Understanding of various types of specialized chemical reactions and their kinetics. Understanding the concepts of surface chemistry and catalysis including homogeneous and heterogeneous catalysis

UNIT-1 18 Hours

A. MATHEMATICAL CONCEPT IN QUANTUM CHEMISTRY: Vector quantities and their properties Complex numbers and Coordinate transformation. Differential and Integral Calculus, Basis rules of differentiation and Integration Applications.

B. The Schrodinger equation and postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz Particle in a box the harmonic oscillator, the rigid rotator, the hydrogenatom.

UNIT-2 18 Hours

BASICS OF THERMODYNAMICS:

Maxwell's thermodynamic relations isotherm, Vant's Hoff hypothesis. Partial molar volume and partial molar heat content. Chemical potential, Gibbs Duhem equation, variation of chemical potential with temperature and pressure. Chemical potential of ideal gases, pure solids, liquids and mixture of ideal gases. Activity and Fugacity, Determination of Fugacity, Variation of Fugacity with temperature and pressure.

UNIT-3 18 Hours

ELECTROCHEMISTRY–I:

Electrochemistry of solution. Debye-Huckel Onsager treatment and its extension, ion solvent interactions. Debey-Huckel-Limiting Law. Debye-Huckel theory for activity coefficient of electrolytic solutions. Determination of activity and activity coefficient, ionic strength, Thermodynamics of electrified interface equations. Derivation of electrocapillarity, Lippmann equation (surface excess), methods of determination.

UNIT-4 18 Hours

CHEMICAL DYNAMICS –I:

Methods of determining rate laws, consecutive reactions, collision theory of reaction rates, steric factor, Activated complex theory, kinetic salt effects, steady state kinetics, and thermodynamic and Kinetic control of reactions. Dynamic chain (Hydrogen-bromine and Hydrogen- chlorine reactions) and Oscillatory reactions (Belousov Zhabotinsky reaction).

UNIT-5 18 Hours

SURFACE CHEMISTRY AND CATALYSIS:

Bimolecular surface reactions: reaction between a gas molecule and an adsorbed molecule, reaction between two adsorbed molecules, inhibition and activation energy of such reactions, catalytic activity at surfaces (volcano curve), transition state theory of surface reactions, rates of chemisorption and desorption, unimolecular and bimolecular surface reactions, comparison of homogeneous and heterogeneous reaction rates, surface heterogeneity.

SUGGESTED READING BOOKS

1. The Chemistry Mathematics Book, E. Steiner, Oxford University Press.
2. Chemical Mathematics, D.M, Hirst, Longman.
3. Applied Mathematics for Physical Chemistry, J. R. Barrante, Prentice Hall.
4. Physical Chemistry, P.W. Atkins, ELBS.
5. Coulson’s Valence, R. Mc Weeny, ELBS.
6. Chemical Kinetics, K. J. Laidler, Pearson.
7. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose, McMillan.
8. Modern Electrochemistry Vol. I and Vol. II, J. O. M.Bockris and A. K. N. Reddy, Plenum.
9. Thermodynamics for Chemists, S. Glasstone, EWP.
10. An Introduction to Electrochemistry S. Glasstone, EWP.
11. Organic Chemist's Book of Orbitals, L. Salem and W. L. Jorgensen, Academic Press
12. The Physical Basis of Organic Chemistry, H. Maskill, Oxford University Press

M.Sc. CHEMISTRY FIRST SEMESTER			
COURSE CODE: MSC 104		**COURSE TYPE: CCC**	
COURSE TITLE: **THEORY AND APPLICATION OF SPECTROSCOPY- I**			
CREDIT: **THEORY: 6**	**PRACTICAL:**	**HOURS:** **THEORY: 90**	**PRACTICAL: 00**
MARKS: **THEORY: 70+30**	**PRACTICAL:**	**MARKS** **THEORY:**	**PRACTICAL:**

OBJECTIVE:

To develop the understanding of basic concepts of spectroscopy and mechanism involved in various spectroscopic techniques including rotational, vibrational, Raman & Scattering.

UNIT-1 18 Hours

UNIFYING PRINCIPLES:

Electromagnetic radiation, interaction of electromagnetic radiation with matter-absorption, emission, transmission, reflection, dispersion, polarization and scattering, Uncertainty relation and natural line width and natural line broadening, transition probability, selection rules, intensity of spectral lines, Born-Oppenheimer approximation, rotational, vibrational and electronic energy levels.

UNIT-2 16 Hours

MICROWAVE SPECTROSCOPY:

Classification of molecules in term of their internal rotation mechanism, determination of rotation energy of diatomic and polyatomic molecules, effect of isotopic substitution on diatomic and polyatomic molecules. Intensities of rotational spectral lines and parameters of rotational and the transition frequencies, non-rigid rotors, Linear and symmetric top polyatomic molecules. Application in determination of bond length.

UNIT-3 18 Hours

INFRA RED SPECTROSCOPY:

Introduction, simple and enharmonic oscillators in vibrational spectroscopy, diatomic-vibrating rotor, Modes of vibration in polyatomic molecules.

UNIT-4 18 Hours

RAMAN SPECTROSCOPY:

Classical and quantum theories of Raman effect, pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, mutual exclusion principle, Resonance Raman spectroscopy, Coherent anti Stokes Raman spectroscopy (CARS), Instrumentation, Application of Raman effect in molecular structures, Raman activity of molecular vibration, structure of CO_2, N_2O, SO_2, NO_2, CIF3.

UNIT-5 20 Hours

SCATTERING SPECTROSCOPY:

A. Electron Diffraction Spectroscopy :Principle, instrumentations and application of Auger spectroscopy and Scanning Electron Microscopy for chemical characterization, electron diffraction of gases and vapours, The Wierl equation and co-related method, application of electron diffraction.

B. Theory, instrumentation and application of turbidimetry, nephelometry and fluorometry, Fluoroscence and phosphorescence and factors affecting them.

SUGGESTED READING BOOKS

1. Modern Spectroscopy, J.M. Hollas, John Wiley.

2. Fundamentals of Molecular Spectroscopy, C.N. Banwell.

3. Spectroscopy, B.K. Sharma, Goel Publication.

4. Organic Spectroscopy: Principles and Applications, Jag Mohan, Narosa Publication.

5. Spectroscopy Methods in Organic Chemistry, D.H. Williams & I. Fleming, Tata Mcgraw-Hill Publication.

6. Spectrophometric Identification of Organic Compounds, R.M. Silversteion & F. X. Webster, John Wiley Publication.

M.Sc. CHEMISTRY FIRST SEMESTER

COURSE CODE: MSC 105	**COURSE TYPE: CCC**
COURSE TITLE: **LAB COURSE- I**	
CREDIT: **THEORY: 00 PRACTICAL:06**	**HOURS:** **THEORY: 00 PRACTICAL:135**
MARKS: **THEORY: PRACTICAL: 100**	**MARKS** **THEORY: PRACTICAL:**

One Experiment from each section is compulsory

Sec-A (24 Marks)

01. Qualitative analysis of mixture containing 8 radicals including 2 less common metals from among the following by semimicro method.

Basic Radicals:

Ag, Pb, Hg, Bi, Cu, Cd, As, Sb, Sn, Fe, Al, Cr, Zn, Mn, Co, Ni, Ba, Sr, Ca, Mg, Na, K, Ce, Th, Zr, W, Te, Ti, Mo, U, V, Be, Li, Au, Pt.

Acid Radicals:

Carbonate, Sulphite, Sulphide, Nitrite, Nitrate, Acetate, Flouride. Chloride, Bromide, Iodide, Sulphate, Borate, Oxalate, Phosphate, Silicate, Thiosulphate, Ferrocyanide, Ferricyanide, Sulphocyanide, Chromate, Arsenate and Permanganate.

Sec-B (20 Marks)

02. QUANTITATIVE ANALYSIS: Quantitative separation and determination of the following pairs of metal ions using gravimetric and volumetric methods: (i) Ag+ (gravimetrically) and Cu^{2+} (Volumetrically) (ii) Cu^{2+} (gravimetrically) and Zn^{2+}(Volumetrically) (iii) Fe^{3+} (gravimetrically) and Ca^{2+}(Volumetrically) (iv) Mg^{2+} (gravimetrically) and Ca^{2+}(Volumetrically)

Sec-C (16 Marks)

03. ESTIMATION OF:

01. Phosphoric acid in commercial orthophosphoric acid.
02. Boric acid in borax.
03. Ammonia in ammonium salt.
04. Manganese dioxide in pyrolusite.
05. Available chlorine in bleaching powder.
06. Hydrogen peroxide in a commercial sample.

04. PREPARATIONS:-

Preparation of selected inorganic compound and their studies by I.R. electronic spectra, Mössbauer, E.S.R. and magnetic susceptibility measurements. Handling of air and moisture sensitive compounds

(1) $VO(acac)_2$

(2) $TiO(C9H8NO)_2.\ 2H_2O$

(3) cis-K $[Cr(C_2O_4)2(H_2O)_2]$

(4) Na $[Cr(NH_3)_2(SCN)_4]$

(5) $Mn(acac)_3$

(6) $K_2[Fe(C_2O_4)_3]$

(7) Prussian Blue, Turnbull's Blue.

(8) $[Co(NH3)_6]\ [Co(NO_2)_6]$

(9) cis-$[Co(trien)(NO_2)_2]Cl.H_2O$

(10) $Hg[Co(SCN)_4]$

(11) $[Co(Py)_2Cl_2]$

(12) $[Ni(NH_3)_6]Cl_2$

(13) $Ni(DMG)_2$

(14) $[Cu(NH3)_4]\ SO_4.\ H_2O$

SUGGESTED BOOKS

1. Vogel's Textbook of Quantitative Analysis, Revi Mendham, ELBS.

2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall.

Mark Scheme:-

Ex. 1 24

Ex 2 20

Ex 3/Ex 4 16

Sessional 20

Viva 20

Total 100

M.Sc. CHEMISTRY FIRST SEMESTER

COURSE CODE: MSC 106	**COURSE TYPE: CCC**
COURSE TITLE: **LAB COURSE- II**	
CREDIT: **THEORY: 00 PRACTICAL:06**	**HOURS:** **THEORY: 00 PRACTICAL:135**
MARKS: **THEORY: PRACTICAL: 100**	**MARKS** **THEORY: PRACTICAL:**

One Experiment from each section is compulsory

Sec- A (30 marks)

ADSORPTION/SURFACE CHEMISTRY

1. To Study Surface tension-Concentration relationship for solutions (Gibbs equation).
2. To Verify the Freundlich and Langmuir Adsorption isotherms using acetic acid/oxalic acid and activated charcoal.
3. Determination of CMC of surfactants

PHASE EQUILIBRIA

1. To Construct the Phase diagram for three component system (e.g. chloroform-acetic acid-water).

CHEMICAL KINETICS

1. Determination of the effect of (a) Change of temperature (b) Change of concentration of reactants and catalyst and (c) Ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reactions.
2. Determination of the velocity constant of hydrolysis of an ester/ionic reaction in micellar media.
3. Determination of the rate constant for the decomposition of hydrogen peroxide by Fe+++and Cu++ions.
4. Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodide ion is oxidized by persulphate ion).

SOLUTIONS/MOLECULAR WEIGHTS

1. Determination of molecular weight of non-volatile substances by Lands berger method.
2. Determination of Molar masses of Naphthalene/acetanilide
3. Molecular weight of polymers by viscosity measurements.

Sec- B (30 Marks)

CONDUCTOMETRY

1. Determination of the velocity constant, order of the reaction and energy of activation for hydrolysis of ethyl acetate by sodium hydroxide conductometrically.
2. Determination of solubility and solubility product of sparingly soluble salts (e.g., PbSO4, BaSO4) conductometrically.
3. Determination of pKa of Acetic acid and verification of Ostwald dilution law.

POTENTIOMETRY/pH METRY

1. Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter.
2. Determination of the dissociation constant of acetic acid in DMSO, DMF, acetone and dioxane by titrating it with KOH.
3. Determination of the dissociation constant of monobasic/dibasic acid by Albert-Serjeant method.
4. Determination of Redox potential of Fe++/Fe+++ system.

POLARIMETRY

1. Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter.
2. Enzyme kinetics –inversion of sucrose.
3. Determination of the specific and molecular rotation of optically active substances.

SUGGESTED BOOKS

1. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall.
2. Macro scale and Microscale Organic Experiments. K.L. Williamson, D.C. Heath.
3. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
4. Handbook of Organic Analysis –Qualitative and Quantitative, H. Clark, Adward Arnold.
5. Vogel's Textbook of Practical Organic Chemistry,
6. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
7. Findley's Practical Physical Chemistry, B.P. Levi
8. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.

Mark Scheme:-

Ex-1 30

Ex -2 30

Sessional 20

Viva 20

Total 100