Department of Pure and Applied Chemistry
University of Kota, Kota

Lecture Plan

M.Sc. I Semester Chemistry

Paper-I: CHEM-511: Inorganic Chemistry

S. No.	Unit wise Broad Topics of the Syllabus	Tentative Lecture No.
Unit-I: Structure and Bonding in Main Group Compounds:		
1.	VSEPR theory – basic assumptions	1
2.	VSEPR theory – examples	2-3
3.	Limitations of VSEPR	4
4.	Walsh diagrams (tri-atomic molecules)	5-6
5.	dπ - pπ bonds	7
6.	Bent rule and energetic of hybridization	8
7.	General trends in acid-base behaviour of binary oxides	9-13
8.	Problem classes	14-15
Unit-II: Metal-Ligand Bonding in Metal Complexes:		
9.	Limitations of crystal field theory	16
10.	Molecular orbital theory	17
11.	Octahedral complexes as examples	18-19
12.	tetrahedral complexes as examples	20-21
13.	square planar complexes as examples	22-23
14.	Π- bonding	24
15.	η^2systems with reference to molecular orbital theory	25
16.	η^3systems with reference to molecular orbital theory	26
17.	η^5systems with reference to molecular orbital theory	27
18.	η^6systems with reference to molecular orbital theory	28
19.	Problem classes	29-30
Unit-III: Metal-Ligand Equilibriums in Solution:		
20.	Stepwise formation and overall formation constants and their interaction	31-32
21.	trends in stepwise constant	33
22.	factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand	34-37
23.	chelate effect and its thermodynamic origin	38
24.	determination of binary formation constants by *p*H-metry and spectrophotometry	39-42
25.	Problem classes	43-45
Unit-IV: Symmetry and Group Theory in Chemistry:		
26.	Symmetry operations and symmetry elements	46
27.	definition of group, subgroup	47
28.	class, order of group	
29.	relation between order of a finite group and its subgroup,	48
30.	similarity transformations and classes	49
31.	molecular point groups and their classification	50-51
32.	Schonflies symbols	52
33.	representations of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh}, *etc*. groups to be worked out explicitly),	53-56

34.	the great orthogonality theorem (without proof) and its importance,	57
35.	characters of a representation	58
36.	properties of character of representation	
37.	Problem classes	59-60
Unit-V: Applications of Group Theory in Chemistry:		
38.	Introduction of character tables,	61
39.	formation of character tables of C_{2v} & C_{3v} point groups	62-65
40.	relationship between reducible and irreducible representations	66
41.	formation of hybrid orbitals:-σ-bonding in trigonal planar (BF_3), tetrahedral (CH_4), square pyramid (BrF_5)	67-68
42.	formation of hybrid orbitals: square planar [$Pt(Cl_4)^{2-}$, XeF_4]	69-70
43.	symmetry aspects of molecular vibrations of H_2O, NH_3 in IR and Raman spectroscopy	71-73
44.	Problem classes	74-75

Range of lectures required for completion of broad topics of the Syllabus : 65-75

Books:

- *Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.*
- *Inorganic Chemistry, J.E. Huhey, Harpes & Row.*
- *Chemistry of the Elements. N.N. Greenwood and A. Earnshow, Pergamon.*
- *Concepts and Models of Inorganic Chemistry, third edition, B. Douglas, D. McDaniel and J. Alexandar, John Wiley.*
- *Magnetio-chemistry, R.L. Carlin, Springer Verlag.*
- *Comprehensive Coordiantion Chemistry eds., Wilkinson, Gillars and Mc Cleverty, Pergamon.*
- *Group Theory, Patel & Patel*
- *Chemical Applications of Group Theory, F. A. Cotton.*
- *Group Theory and its Application, P. Bhattacharya, Himalaya Publication*
- *Group Theory and its Application, Ramashanker & S. C. Ameta, Sadguru Publication*
- *Group Theory and its Application, Ramakrishanan and Swaminathan, Vishal Publication.*

Paper-II: CHEM-512: Organic Chemistry

S. No.	**Unit wise Broad Topics of the Syllabus**	**Tentative Lecture No.**
Unit-I: Nature of Bonding in Organic Molecules:		
1.	Delocalized chemical bonding: conjugation, cross-conjugation, resonance, hyper-conjugation, bonding in fullerenes, tautomerism;	1-4
2.	Hűckel's rule, aromaticity in benzenoid and non-benzenoid compounds	5-7
3.	anti-aromaticity, homo-aromaticity	8
4.	alternant and non-alternant hydrocarbons	9
5.	energy level of π-molecular orbitals, annulenes,	10
6.	bonds weaker than covalent bond: addition compounds (crown ether complexes and cryptands)	11-13
7.	inclusion compounds (catenanes and rotaxanes)	14-15
Unit-II: : Structure and Reactivity:		
8.	Thermodynamic and kinetic aspects of reactions	16
9.	resonance and field effects, steric effect, isotope effect, effects of structure on reactivity	17-18

10.	The Hammett equation and linear free energy relationship, substituent and reaction constants, Taft equation	19-20
11.	Types of reaction mechanism, potential energy diagram, transition states and intermediates	21
12.	methods of determining mechanisms (product analysis, intermediates analysis, isotope effect, kinetic and stereochemical studies)	22-25
13.	Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes	26-30
Unit-III: Stereochemistry:		
14.	Conformational analysis of cycloalkanes & decalins, conformation of sugars	31-32
15.	effect of conformation on reactivity	33
16.	strain due to unavoidable crowding	34
17.	elements of symmetry, chirality, molecules with more than one chiral centre, threo and erythro isomers	35-36
18.	methods of resolution	37
19.	optical purity, enantiotopic and diastereotopic atoms, groups and faces	38
20.	stereospecific and stereoselective synthesis	39
21.	optical activity in the absence of chiral carbon (biphenyls, allenes and spirane)	40
22.	chirality due to helical shape	41
23.	invertomers	42
24.	asymmetric synthesis	43
25.	determination of configuration (absolute & relative) and conformation	44-45
Unit-IV: Aliphatic and Aromatic Nucleophilic Substitution:		
26.	The S_N2, S_N1, mixed S_N1 & S_N2, S_Ni and SET mechanisms	46
27.	Aliphatic Nucleophilic Substitution: reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium	47-48
28.	neighbouring group participation by π- and σ-bonds	49
29.	classical and non-classical carbocations, phenonium ions, norbornyl systems	50
30.	rearrangement of epoxides, transannular rearrangement	51
31.	nucleophilic substitution at vinylic, allylic and aliphatic trigonal carbon	52
32.	phase transfer catalysis	53-54
33.	ambient nucleophiles, regioselectivity	55-56
34.	S_NAr S_N1, S_NAr S_N2 , benzyne and SR_N1 mechanisms	57
35.	Aromatic Nucleophilic Substitution: reactivity effects of substrate structure, leaving group and attacking nucleophile	58-59
36.	von Richte, Sommelet-Hauser, and Smiles rearrangements	60
Unit-V: Aliphatic and Aromatic Electrophilic Substitution:		
37.	Bimolecular mechanisms SE2, SE1, SEi mechanism	61
38.	electrophilic substitution accompanied by double bond shifts	
39.	effect of substrates, leaving groups and the solvent polarity on the reactivity	62
40.	Arenium ion mechanism	63
41.	orientation and reactivity in benzene ring, energy profile diagrams	
42.	ortho/para ratio, ipso attack	64
43.	orientation and reactivity in other ring systems	65
44.	quantitative treatment of reactivity in substrates and electrophiles, diazonium coupling	66

45.	Vilsmeir-Haack reaction, Reimer-Tiemann reaction, Gatterman-Koch reaction, Houben-Hoesch reaction, Fries rearrangement, Bischler-Napieralski reaction	67-75

Range of lectures required for completion of broad topics of the Syllabus : 65-75

Books:

- *Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.*
- *Organic Chemistry, Clayden, Nick Geeves and Staurt Warren, Oxford University Press*
- *Advanced Organic Chemistry: Reactions, Mechanism and Structure, Jerry March, John Wiley.*
- *Advanced Organic Chemistry, Part A and Part B, F.A. Carey and R.J. Sundberg, Plenum.*
- *A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.*
- *Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.*
- *Reaction Mechanism in Organic Chemistry, S. M. Mukherjee and S. P. Singh, Macmillan.*
- *Textbook of Organic Chemistry by P S Kalsi, New Age International*
- *Organic Reactions, Stereochemistry and Mechanism (Through Solved Problems) by PS Kalsi, New Age*
- *Stereochemistry of Carbon Compounds, Ernest L. Eliel, TataMcGraw Hill.*
- *Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.*
- *Stereochemisty of Organic Compounds, P.S. Kalsi, New Age International.*
- *Stereochemistry, Conformation and Mechanism by P S Kalsi, New Age International*

Paper-III: CHEM-513: Physical Chemistry

S. No.	Unit wise Broad Topics of the Syllabus	Tentative Lecture No.
Unit-I: Quantum Chemistry-I:		
1.	Introduction to quantum mechanics and Schrodinger equation	1-2
2.	the postulates of quantum mechanics and numerical	3-4
3.	discussion of solutions of the Schrodinger equation to some model	5-6
4.	Schrodinger equation to harmonic oscillator, rigid rotor, hydrogen atom	7-8
5.	The variation theorem and its applications	9-10
6.	Linear variation principle,	11
7.	perturbation theory (first order and non-degenerate) and perturbation	12-13
8.	applications of variation method and perturbation theory to Helium atom.	14-15
Unit-II: Quantum Chemistry-II:		
9.	Angular Momentum: Ordinary angular momentum,	16
10.	generalized angular momentum,	17
11.	Eigen functions and Eigen values for angular momentum,	18-19
12.	operator using Ladder operators addition of angular momentum	20-21
13.	Molecular Orbital Theory: Hűckel theory of conjugated systems	22
14.	bond and charge density calculations,	23-25
15.	applications to ethylene, butadiene, cyclopropenyl radical cyclobutadiene,	26-29
16.	introduction to extended Hűckel theory.	30
Unit-III: Chemical Dynamics:		
17.	Methods of determining rate laws,	31
18.	collision theory of reaction rates, activated complex theory,	32-33
19.	steric factors,	34
20.	kinetic salt effects, steady state kinetics,	35-36

21.	kinetic and thermodynamic control of reactions	37
22.	Dynamics of chain reactions (hydrogen-bromine reaction),	38
23.	photochemical reactions (hydrogen-bromine and hydrogen-chlorine reactions),	39
24.	kinetics of enzyme catalyzed reactions,	40-41
25.	general features of fast reactions,	42
26.	study of fast reactions (flow method, relaxation method, flash photolysis),	43-44
27.	dynamics of unimolecular reactions (Lindemann Hinshelwood and Rice-Ramsperger-Kassel-Marcus).	45
Unit-IV: Adsorption and Micelles:		
28.	Surface tension, capillary action,	46
29.	pressure difference across curved surface (Laplace equation),	47-48
30.	vapour pressure of droplets (Kelvin equation),	49
31.	Gibbs adsorption isotherm,	50
32.	estimation of surface area (BET equation),	51
33.	surface films on liquids (Electro-kinetic phenomenon),	52
34.	catalytic activity at surfaces, different isotherms,	53-54
35.	Surface active agents, classification of surface active agents,	55
36.	micellization, hydrophobic interaction,	56
37.	critical micellar concentration (CMC), factors affecting the CMC of surfactants,	57
38.	counter ion binding to micelles,	58
39.	thermodynamics of micellization-phase separation and mass action models,	59
40.	solubilisation, micro emulsion, reverse micelles.	60
Unit-V : Macromolecules:		
41.	Definition & types of polymers, mechanism of polymerization,	61-62
42.	electrically conducting, fire resistant, liquid crystal polymers,	
43.	kinetics of polymerization,	63-64
44.	molecular mass determination (osmometry, viscometry, diffusion, light scattering and sedimentation methods),	65-70
45.	chain configuration of macromolecules,	71-72
46.	calculation of average dimension of various chain structures.	73-75

Range of lectures required for completion of broad topics of the Syllabus : 65-75

Books:

- *Physical Chemistry, P.W. Atkins, ELBS.*
- *Introduction to Quantum Chemistry, A.K. Chandra, Tata Mc Graw Hill.*
- *Quantum Chemistry, R. K. Prasad,*
- *Coulson's Valence, R.Mc Weeny, ELBS.*
- *Chemical Kinetics. K.J. Laidler, McGraw-Hill.*
- *Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum.*
- *Modern Electrochemistry Vol. 1 and Vol II J.O.M. Bockris and A.K.N. Reddy, Planum.*
- *Introduction to Polymer Science, V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar, Wiley Eastern.*
- *Advanced Physical Chemistry, Gurudeep Raj,Goel Publication House*
- *Adsorption and Catalysis, G. Whitmore, Sarup & Sons Publishers.*

Paper-IV: CHEM-514: Mathematics for Chemists (For students without Mathematics in B. Sc.)

S. No.	Unit wise Broad Topics of the Syllabus	Tentative Lecture No.
Unit-I: Basic Mathematics:		
1.	Matrix algebra, determinants,	1-2
2.	linear equations,	3
3.	Eigen values and Eigen vectors,	4-5
4.	basic rules for differentiation,	6-7
5.	applications of differentiation in chemistry,	8-9
6.	partial differentiations, maxima and minima,	10-11
7.	basic rules for integration,	12-13
8.	application of integral calculus	14-15
Unit-II: Mathematics and Linear Programming Problems:		
9.	Differential equations,	16
10.	solution of linear differential equations,	17
11.	applications of differential equations;	18-19
12.	Vectors: definition dot, triple and cross product,	20
13.	Vector Calculus: gradient, divergence and curl;	21
14.	linear programming problems: Formulation, graphical solution, simplex method, solution by simplex method (up to 2 variables)	23-30
Unit-III: Basic Operations Research:		
15.	Operations research-concept and applications of OR,	31-32
16.	transportation problem,	33-34
17.	assignment problems,	35-36
18.	basic concepts of inventory control,	37-38
19.	inventory control models,	39-40
20.	basic concepts of replacement problems,	41-42
21.	solutions of replacement problems,	43-44
22.	basic concepts of theory of reliability.	45
Unit-IV: Basic Statistics:		
23.	Quality control and ABC analysis	46-48
24.	curve fitting: methods of least square,	49-50
25.	permutation & combination,	51-52
26.	probability theory,	53
27.	representation of data-histogram, Pie chart,	54
28.	measures of central tendency,	55
29.	deviation, dispersion,	56-57
30.	skewness and kurtosis	58
31.	random variables, mathematical expectations.	59-60
Unit-V : Statistical Inference:		
32.	Probability distribution: discrete (binomial and Poisson),	61
33.	probability distribution: continuous (normal) distribution,	62
34.	correlation,	63-64
35.	regression,	65-66
36.	sampling concepts,	67-68
37.	sampling test for mean,	69
38.	testing of hypothesis-test based on t-distribution (t-test),	70-71
39.	test based on Chi square distribution (Chi square test),	72-73
40.	basic concepts of estimation	74-75

Range of lectures required for completion of broad topics of the Syllabus : 65-75

Books:

- *Mathematical Statistics-Gupta and Kapoor.*
- *Operations Research-Kanti Swaroop.*
- *The Chemistry Mathematics Book, E. Steiner, Oxford University Press.*
- *Mathematics for Chemistry, Doggett and Sucliffe, Longman.*
- *Mathematical for Physical Chemistry: F. Daniels, Mc Graw Hill.*
- *Chemical Mathematics D.M. Hirst, Longman.*
- *Applied Mathematics for Physical Chemistery, J.R. Barrnte, Prentice Hall.*
- *Basic Mathematics for Chemists, Tebbutt, Wiley.*

OR

Paper-IV: CHEM-514: Biology for Chemists (For students without Biology in B. Sc.)

S. No.	Unit wise Broad Topics of the Syllabus	Tentative Lecture No.
Unit-I: Cell Structure and Functions:		
1.	Structure of prokaryotic and eukaryotic cells,	1-3
2.	intracellular organelles and their functions,	4-6
3.	comparisons of plant and animal cells,	7
4.	overview of metabolic processes: catabolism and anabolism,	8-10
5.	ATP-the biological energy currency,	11
6.	origin of life: unique properties of carbon, chemical evolution and rise of living systems.	12-15
Unit-II: Carbohydrates:		
7.	Monosaccharides: Structure, conformation	16
8.	functions of important derivatives of monosaccharides;	17
9.	structural polysaccharides: cellulose and chitin,	18-19
10.	storage polysaccharides: starch and glycogen,	20-21
11.	structure and biological functions of glucosaminoglycans or mucopolysaccharides,	22-23
12.	glycoproteins and glycolipids,	24
13.	role of sugars in biological recognition,	25
14.	blood group substances;	
15.	carbohydrate metabolism: Kreb's cycle, glycolysis, glycogenesis and glycogenolysis, gluconeogenesis, pentose phosphate pathway	26-30
Unit-III:Lipids:		
16.	Fatty acids,	31-32
17.	structure and function of triacylglycerols,	33-34
18.	structure and function of glycerophospholipids, sphingolipids,	35-36
19.	structure and function of cholesterol, bile acids, prostaglandins;	37-38
20.	liproproteins: composition and function, role in atherosclerosis;	39
21.	properties of lipid aggregates: micelles, bilayers,	40
22.	liposomes and their possible biological functions;	41
23.	biological membranes,	42
24.	fluid mosaic model of membrane structure,	43
25.	lipid metabolism: β-oxidation of fatty acids.	44-45

Unit-IV: Amino-acids and Proteins:		
26.	Amino acid metabolism: degradation and biosynthesis of amino acids,	46-47
27.	sequence determination: chemical / enzymatic / mass spectral, racemization / detection,	48-49
28.	chemistry of oxytocin and tryptophan releasing hormone (TRH)	50
29.	Chemical and enzymatic hydrolysis of proteins,	51
30.	amino acid sequencing,	52
31.	secondary structure of proteins,	53-54
32.	force responsible for holding of secondary structures,	
33.	α-helix, β-sheets,	55
34.	triple helix structure of collagen,	56
35.	tertiary structure of protein: folding and domain structure,	57-58
36.	quaternary structure	59-60
Unit-V : Nucleic Acids:		
37.	Purine and pyrimidine bases of nucleic acids,	61
38.	structure of ribonucleic acids (RNA)	62-63
39.	structure of deoxyribonucleic acid (DNA),	64-65
40.	double helix model of DNA,	66-67
41.	chemical and enzymatic hydrolysis of nucleic acids,	68
42.	chemical basis of heredity,	69
43.	an overview of replication, transcription,	70-71
44.	translation and genetic code,	72-73
45.	chemical synthesis of mono- and tri-nucleosides	74-75

Range of lectures required for completion of broad topics of the Syllabus : 65-75

Books:

- *Principles of Biochemistry, A.L. Lehnigher, Worth Publishers.*
- *Biochemistry, L. Stryer, W.H. Freeman.*
- *Biochemistry, J. David Rawn, Neil Patterson.*
- *Biochemistry, Voet and Voet, John Wiley.*
- *Outlines of Biochemistry E.E. Conn and P.K. Stumpf, John Wiley.*