

**M. Sc. Chemistry 2018-2019**  
**Two Years (Four Semester CBCS)**  
**Scheme of Examination (Semester I)**

Paper Code	Title of Course (paper)	Type of course	Hour/Week	Level	Credits	Marks			Total	Remarks
						Internal	External	Min. Marks		
						Max.	Max.			
MCH 101	Inorganic Chemistry I	Core	5	A	4	40	60	35	100	-
MCH 102	Organic Chemistry I	Core	5	A	4	40	60	35	100	-
MCH 103	Physical Chemistry I	Core	5	A	4	40	60	35	100	-
MCH 104	Group Theory & Spectroscopy	Core	5	A	3	40	60	35	100	-
MCH *105 a/b	a) Mathematics and Statistics for Chemists	Remedial	4	B	3	40	60	35	100	one remedial paper is compulsory
	b) Biology for Chemists									
MCH 106	Entrepreneurship Development	-	4	B	4	40	60	35	100	-
Practical MCHP 107	Inorganic Chemistry Practical I	-	6	-	2	34		35	100	It include marks for attendance
	Organic Chemistry Practical I	-	6	-	2	33				
	Physical Chemistry Practical I	-	6	-	2	33				
MCHP 108	Comprehensive Viva	-	-	-	2	100		35	100	-
<b>Total</b>			<b>46</b>		<b>30</b>	<b>800</b>		<b>280</b>	<b>800</b>	<b>-</b>

\* 105 a For students having Biology in B. Sc.

\* 105 b For students having Mathematics in

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**M. Sc. Chemistry 2018-2019**  
**Two Years ( Four Semester CBCS)**  
**Scheme of Examination (Semester II)**

Paper Code	Title of Course (paper)	Type of course	Hour/Week	Level	Credits	Marks			Total	Remarks
						Internal	External	Min. Marks		
						Max.	Max.			
MCH 201	Inorganic Chemistry II	Core	5	A	4	40	60	35	100	-
MCH 202	Organic Chemistry II	Core	5	A	4	40	60	35	100	-
MCH 203	Physical Chemistry II	Core	5	A	4	40	60	35	100	-
MCH 204	Spectroscopy and Diffraction Methods	Core	5	A	3	40	60	35	100	-
MCH *205 a/b	a) Computer for Chemists	Remedial	4	B	3	40	60	35	100	one remedial paper is compulsory
	b) Cheminformatics									
	c) Bioinformatics									
MCH 206	Communication Skill	-	4	B	4	40	60	35	100	-
Practical MCHP 207	Inorganic Chemistry Practical II	-	6	-	2	34		-	100	It include marks for attendance
	Organic Chemistry Practical II	-	6	-	2	33		-		
	Physical Chemistry Practical II	-	6	-	2	33		-		
MCH 208	Comprehensive Viva	-	-	-	2	100	-	-	100	-
<b>Total</b>		-	<b>46</b>		<b>30</b>	<b>800</b>		<b>280</b>	<b>800</b>	

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**M. Sc. Chemistry 2018-2019**  
**Two Years (Four Semester CBCS)**  
**Scheme of Examination (Semester III)**

Paper Code	Title of Course (paper)	Type of course	Hour/Week	Level	Credits	Marks			Total	Remarks
						Internal	External	Min. Marks		
						Max.	Max.			
MCH 301	Application of Spectroscopy -I	Core	5	A	4	40	60	35	100	
MCH 302	Photochemistry and Pericyclic Reactions	Core	5	A	4	40	60	35	100	
MCH 303	Instrumental method of analysis	Core	5	A	4	40	60	35	100	
MCH 304 a-f	*Elective I (Discipline centric)	Core	5	A	3	40	60	35	100	
MCH 305g	*Elective II (Interdisciplinary)	Remedial	4	B	3	40	60	35	100	
MCH 306	Personality Development		4	B	4	40	60	35	100	
MCHP 307	Inorganic Chemistry Practical III	-	6	-	2	34		35	100	It include marks for attendance
	Organic Chemistry Practical III	-	6	-	2	33				
	Physical Chemistry Practical III	-	6	-	2	33				
MCH 308	Comprehensive Viva	-	-	-	2	100		35	100	
<b>Total</b>			<b>46</b>		<b>30</b>	<b>800</b>		<b>280</b>	<b>800</b>	

**\*ELECTIVE PAPERS**

**Discipline centric**

OPT-1 MCH-304A Polymers

OPT-2 MCH-304B Heterocyclic Chemistry

OPT-3 MCH-304C Bioorganic Chemistry

OPT-4 MCH-304D Biophysical Chemistry

OPT-5 MCH-304E Bioinorganic Chemistry

OPT-6 MCH-304F Electrochemistry

**Interdisciplinary**

OPT-1 MCH-304G Environmental Chemistry

**M. Sc. Chemistry 2018-2019**  
**Two Years (Four Semester CBCS)**  
**Scheme of Examination (Semester IV)**

Paper Code	Title of Course (paper)	Type of course	Hour/Week	Level	Credits	Marks			Total	Remarks
						Internal	External	Min. Marks		
						Max.	Max.			
MCH 401	Application of Spectroscopy II	Core	5	A	4	40	60	35	100	
MCH 402	Solid State Chemistry	Core	5	A	4	40	60	35	100	
MCH 403	Organic Synthesis	Core	5	A	4	40	60	35	100	
MCH 404a-f	Elective I (Discipline centric)	Core	5	A	3	40	60	35	100	
MCH 405g	Elective II (Interdisciplinary)	Remedial	4	B	3	40	60	35	100	
MCH 406	Tourism Management	-	4	B	4	40	60	35	100	
MCHP 407	Inorganic Chemistry Laboratory IV	-	6	-	2	34		35	100	It include marks for attendance
	Organic Chemistry Laboratory IV	-	6	-	2	33		35		
	Physical Chemistry Laboratory IV	-	6	-	2	33		35		
MCH 408	Comprehensive Viva	-	-	-	2	100		35	100	
<b>Total</b>			<b>46</b>		<b>30</b>	<b>800</b>		<b>280</b>	<b>800</b>	

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**\*ELECTIVE PAPERS**

**Discipline centric**

- OPT-1 MCH-404A Natural Product Chemistry
- OPT-2 MCH-404B Analytical Chemistry
- OPT-3 MCH-404C Medicinal Chemistry
- OPT-4 MCH-404D Material Chemistry
- OPT-5 MCH-404E Supramolecular and Nano Chemistry
- OPT-6 MCH-404F Chemistry of Textile Printing

**Interdisciplinary**

- OPT-1 MCH-304G Instrumental Methods of Analysis

2018-19

## SEMESTER I

Paper-I

MCH-101: INORGANIC CHEMISTRY I

(5 credits)

### Unit-I

#### Stereochemistry and Bonding in Main Group Compounds :

VSEPR, Walsh diagram (triatomic and penta-atomic molecules),  $d\pi-p\pi$  bond, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules.

### Unit-II

#### Metal-Ligand Equilibrium in Solution

Stepwise and overall formation constants and their interaction, trends in stepwise constant, 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 potentiometry and spectrophotometry.

### Unit-III

#### Reaction Mechanism of Transition Metal Complexes

Energy profile of a reaction, reactivity of metal complex, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favor of conjugate mechanism, anion reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction. Redox reaction, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions.

### Unit-IV

#### Metal-Ligand bonding

Limitations of Valence bond theory, Crystal field theory, molecular orbital theory for bonding in octahedral, tetrahedral and square planar complexes,  $\pi$ -bonding and molecular orbital theory.

### Unit-V

#### HSAB Theory

Classification of acids and bases as hard and soft; HSAB principle, theoretical basis of hardness and softness; Lewis-acid base reactivity approximation; donor and acceptor numbers, E and C equation; applications of HSAB concept.

#### Books Suggested :

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
3. Chemistry of the Elements. N.N. Greenwood and A. Earnshaw, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
5. Magnetochemistry, R.1. Carlin, Springer Verlag.
6. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and J.A. Mc Cleverty, Pergamon.

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## Paper-II

### MCH-102: ORGANIC CHEMISTRY I

(5 credits)

#### Unit-I

##### Nature of Bonding in Organic Molecules

Delocalized chemical bonding-conjugation, cross conjugation, resonance hyperconjugation, bonding in fullerenes, tautomerism. Aromaticity in benzenoid and non-benzenoid compounds, alternate and non-alternate hydrocarbons. Huckel's rule, energy. Level of  $\pi$ -molecular orbitals, annulenes, anti-aromaticity, homo-aromaticity, PMO approach. Bonds weaker than covalent-addition compounds, crown ether complexes and cryptands, inclusion compounds, catenanes and rotaxanes.

#### Unit-II

##### Stereochemistry

Strain due to unavoidable crowding Elements of symmetry, chirality, molecules with more than one chiral center, threo and erythro isomers, Sequence rule, R, S- nomenclature, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis, Asymmetric synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spirane chirality due to helical shape. Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

#### Unit III

##### Conformational analysis and reactive intermediates

Conformational analysis of cycloalkanes, decalines, effect of conformation on reactivity, conformation of sugars. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. The Hammett equation and linear free energy relationship, substituents and reaction constants, Taft equation.

#### Unit-IV

##### Reaction Mechanism : Structure and Reactivity

Type of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Effect of structure on reactivity: resonance and field effect, steric effects, Hammond's postulate, Curtir-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotopes effects

#### Unit-V

##### Aliphatic Nucleophilic Substitution

The  $SN^2$ ,  $SN^1$  mixed  $SN^1$  and  $SN^2$  and SET mechanism. The neighboring group mechanism, neighboring group participation by p and s bonds, anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, norbornyl systems, Common carbocation rearrangements : Pinacol-pinacolone, Wagner-Meerwein and Demjanov, The  $SNi$  mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity.

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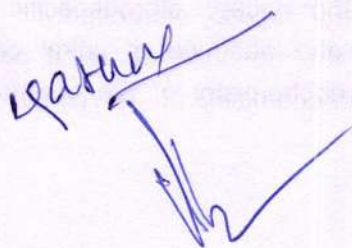
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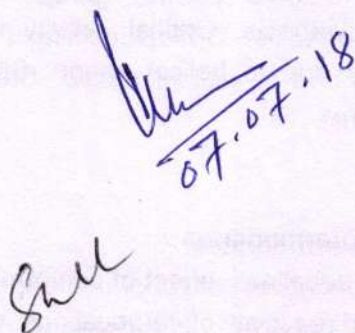
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### Book Suggested

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentice-Hall.
6. Organic Reaction and Mechanism, P.S. Kalsi, New age international, New-Delhi.
7. Modern Organic Reactions, H.O. House, Benjamin.
8. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professionals.
9. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
10. Pericyclic Reactions, S.M. Mukherji, Macmillan, India
11. Stereochemistry, D. Nasipuri, New Age International.
12. Organic reactions, Stereochemistry and mechanism, P.S. Kalsi, New Age International.

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Paper-III

MCH-103: PHYSICAL CHEMISTRY - I

(5 credits)

**Unit I**

**Introduction to Exact Quantum Mechanical Results**

Schrödinger equation and the postulates of quantum mechanics, Discussion of solutions of the Schrödinger equation to some model systems viz., particle in a box, the harmonic oscillator, the rigid rotor, the hydrogen atom and hydrogen like wave function (shapes of orbitals), helium atom. Charge cloud representation of orbitals, Principle of causality, Tunneling effect.

**Unit-II**

**Approximate Methods**

The variation theorem, linear variation principle. Perturbation theory (First order and nondegenerate). Applications of variation method and perturbation theory to the Helium atom.

Huckel theory of conjugated systems, bond and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical cyclobutadiene etc. Introduction to extended Huckel theory.

Ordinary angular momentum, generalized angular momentum, eigenfunctions for angular momentum, eigenvalues of angular momentum operator using ladder operators addition of angular momenta, spin, antisymmetry and Pauli exclusion principle.

**Unit-III**

**Nuclear Chemistry**

Introduction, characteristics of subatomic particles, Gluons, Quarks, Bosons, Nuclear stability, n/p ratio. nuclear energy and its future prospects, Mass defect, Packing fraction, Q value, Nuclear Models - Liquid drop Model, Shell Model, Collective Model, Fermi Gas Model. Nuclear reactions, Nuclear cross section, Nuclear fission, nuclear fusion and their significance, radioactivity, radioactive decay, radioactive isotopes and their uses, tracer techniques, Geiger Muller counter, Scintillation counter.

**Unit-IV**

**Classical Thermodynamics**

Free energy, chemical potential and entropies. Partial molar free energy, partial molar volume and partial molar heat content, their determination and significance.

Concept of fugacity and determination of fugacity. Non-ideal systems: Excess function for non-ideal solutions. Concept of activity and activity coefficient, determination of activity and activity coefficients; Debye Huckel theory for activity coefficient of electrolytic solutions, ionic strength. Application of phase rule to three component systems; second order phase transitions.

**Unit-V**

**Statistical Thermodynamics**

Concept of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulates of ensemble averaging. Canonical, grand canonical and micro-canonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers). Partition functions-translation, rotational, vibrational and electronic partition functions, Calculation of

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thermodynamic properties in terms of partition. Applications of partition function. Fermi-Dirac Statistics. Bose-Einstein statistics.

#### Books Suggested

1. Physical Chemistry: P.W. Atkins, ELBS.
2. Introduction to Quantum Chemistry: A.K. Chandra, Tata Mc Graw Hill.
3. Quantum Chemistry, : Ira N. Levine, Prentice Hall.
4. Chemical Kinetics: K.J. Laidler, McGraw-Hill.
5. Principles of Physical Chemistry: Puri, Sharma ,Pathania Himalaya Publication
6. Basic Concepts of Nuclear Chemistry : Arnikaar.
7. Basic Concepts of Nuclear Chemistry : Overman
8. Nuclear Physics and Chemistry: Harvey.
9. Source Book of Atomic Energy : Glasston
10. Introduction to Quantum Chemistry: R.K. Prasad, New Age Publication.
11. Physical Chemistry: T.Engel & Philip Reid. Pearson Education (2006)
12. Thermodynamics for Chemists : Glasston

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## Paper-IV

### MCH-104: Group Theory & Spectroscopy I

(5 credits)

#### Unit-I

##### Symmetry and Group theory in Chemistry

Symmetry elements and symmetry operations, definition of group, subgroup: Examples as  $\text{H}_2\text{O}$ ,  $\text{NH}_3$ ,  $\text{BF}_3$ ,  $[\text{Ni}(\text{CN})_4]^{2-}$ ,  $\text{PCl}_5$ ,  $\text{H}_2\text{O}_2$ ,  $\text{C}_2\text{H}_4$ , Trans dichloro ethylene,  $\text{C}_6\text{H}_6$ ,  $\text{CO}_2$ ,  $\text{H-Cl}$ , allene etc.

Symmetry operations as matrices, conditions for a set of elements to be called a group, Conjugacy relation and classes. Point symmetry group, character of a representation. The great orthogonality theorem (without proof) and its importance, symbols for irreducible representations, character tables and their uses in spectroscopy. Derivation of character table for  $\text{C}_{2v}$  and  $\text{C}_{3v}$  point groups.

#### Unit-II

##### Microwave Spectroscopy

Characterisation of electromagnetic radiation, The Quantization of energy, Regions of the complete electromagnetic spectrum. Basic Elements of Practical Spectroscopy, Single to noise resolving power, The width and Intensity of spectral lines, Basic concept of Fourier Transform spectroscopy, Elementary idea of Stimulated Emission: LASERS, Synchrotron Radiations and their application.

Classification of molecules, Diatomic rigid rotator and non-rigid rotator model, allowed rotational energies, Population of energy levels, calculation of bond distance of carbon mono oxide, effect of isotopic substitution, Stark effect, Chemical Analysis by microwave spectroscopy, The microwave oven.

#### Unit-III

##### Infrared and Raman Spectroscopy

Energy of diatomic molecule, The simple harmonic oscillator, The Anharmonic Oscillator (Morse potential energy diagram), The diatomic vibrating Rotator, vibration-rotation spectroscopy. P.Q.R. branches, vibrations of polyatomic molecules. Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intensities, The carbon dioxide LASER.

Polarisation of light and Raman Effect, Classical and quantum theories of Raman Effect. Pure rotational and vibrational Raman spectra, selection rules, mutual exclusion principle, Structure determination from Raman and IR spectroscopy, Resonance Raman spectroscopy, Coherent Anti Stokes Raman spectroscopy (CARS).

#### Unit-IV

##### Electronic Spectroscopy

Energy levels of molecular orbitals, electronic spectra of diatomic molecules, The Born- Oppenheimer Approximation, Vibrational Coarse Structure: progressions, The Franck-Condon principle, Dissociation Energy and Dissociation Products, Rotational Fine structure of Electronic-vibration transitions,

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electronic spectra of polyatomic molecules, Change of shape on excitation, Chemical Analysis by Electronic Spectroscopy. The Re-emission of energy by an excited molecule.

#### Unit-V

#### Nuclear Magnetic Resonance Spectroscopy

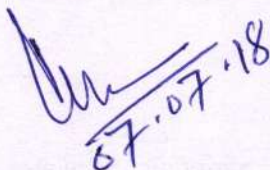
Nuclear spin, nuclear resonance, Population of Energy levels, The Larmor Precession, Relaxation Times, chemical shift and factors influencing chemical shift, shielding and deshielding, anisotropic effect, internal standards, spin-spin coupling, equivalent and non-equivalent protons, CW and FT-NMR, advantages of FT NMR, integration coupling (1st order analysis), basic ideas about instrument

#### Books suggested

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Applied Electron Spectroscopy for chemical analysis d. H. Windawi and F.L. Ho, Wiley Interscience.
3. NMR, NQR, EPr and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.
4. Physical Methods in Chemistry, R.S. Drago, Saunders College.
5. Chemical Applications of Group Theory, F.A. Cotton.
6. Introduction to Molecular Spectroscopy, G.M. Barrow, Mc Graw Hill.
7. Basic Principles of Spectroscopy, R. Chang, Mc Graw Hill.
8. Theory and Application of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBH, Oxford.
9. Introduction to Photoelectron Spectroscopy, P.K. Ghosh, John Wiley.
10. Introduction to Magnetic Resonance. A Carrington and A.D. Maclachalan, Harper & Row.



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**Paper-V**

**MCH-105 (a) : Mathematics and Statistics for Chemists**

**(4 credits)**

(For students without Mathematics in B.Sc.)

**Unit-I**

**Matrix algebra and Vector**

A. Matrix algebra: addition and multiplication, inverse, adjoint and transpose of matrices, special matrices (symmetric, hermitian, skew hermitian, unit, diagonal etc) and their properties, matrix equations: homogeneous, non homogeneous, linear equations and conditions for the solution, linear dependence and independence of vectors, matrix eigen values and eigenvectors, diagonalization, determinants (examples from Huckel theory).

B. Vectors- dot, cross and triple products etc. the gradient, vector calculus, Gauss's theorem

**Unit II**

**Differential calculus and differential equations**

Functions, continuity and differentiability, rules for differentiation, applications of differential calculus including maxima and minima (examples related to maximally populated rotational energy levels, Bohr's radius and most probable velocity from Maxwell distribution etc), exact and inexact differentials with their applications to thermodynamic properties.

Variables-separable and exact first order differential equations, homogeneous, exact and linear equations, applications to chemical kinetics, secular equilibrium, quantum chemistry etc, solutions of differential equations by the power series method, solutions of harmonic oscillator, spherical harmonics, second order differential equations and their solutions.

**Unit III**

**Integral calculus**

Basic rules for integration, integration by parts, partial fraction and substitution, reduction formulae, applications of integral calculus, functions of several variables, partial differentiation, co-ordinate transformations e.g. Cartesian to spherical polar, curve sketching.

**Unit IV**

**Permutation and probability**

Permutations and combinations, probability and probability theorems, probability curves, average, root mean square and most probable errors, example from the kinetic theory of gases etc.

**Unit V**

**Statistical tests and Error Analysis:**

Accuracy, precision, mean, median, mode, significant figures and computation, mean deviation and standard deviation, classification of errors, Propagation of errors, Confidence limits, Tests of Significance, Rejection of results and Problems. Least square methods, regression coefficient, F-test, t-test and Chi-square test.

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**Book Suggested**

1. The chemistry Mathematics Book, E. Steiner, Oxford University Press.
2. Mathematics for chemistry, Doggett and Suiclific, Logman.
3. Mathematical for Physical chemistry : F. Daniels, Mc. Graw Hill.
4. Chemical Mathematics D.M. Hirst, Longman.
5. Applied Mathematics for Physical Chemistry, J.R. Barante, Prentice Hall.
6. Mathematics for Chemists, Tebbutt, Wiley.

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## Paper-V

### CH-105 (b) BIOLOGY FOR CHEMISTS

(4 credits)

(For students without Biology in B.Sc.)

#### Unit-I

##### Cell Structure and Functions

Structure prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plant and animal cells. Overview and their functions, comparison of plant and animal cells. Overview of metabolic processes-catabolism and anabolism. ATP – the biological energy currency. Origin of life-unique properties of carbon chemical evolution and rise of living systems. Introduction to bio-molecules, building blocks of biomacromolecules.

#### Unit-II

##### Carbohydrates

Conformation of monosaccharides, structure and functions of important derivatives of mono-saccharides like glycosides, deoxy sugars, myoinositol, amino sugars. N-acetylmuramic acid, sialic acid disaccharides and polysaccharides. Structural polysaccharides cellulose and chitin. Storage polysaccharides-starch and glycogen. Structure and biological function of glucosaminoglycans of mucopolysaccharides. Carbohydrates of glycoproteins and glycolipids. Role of sugars in biological recognition. Blood group substances. Ascorbic acid.

#### Unit-III

##### Lipid

Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins-composition and function, role in atherosclerosis. Properties of lipid aggregates-micelles, bilayers, liposomes and their possible biological functions. Biological membranes. Fluid mosaic model of membrane structure. Lipid metabolism-oxidation of fatty acids.

#### Unit-IV

##### Amino-acids, Peptides and Proteins

Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins. force responsible for holding of secondary structures.  $\alpha$ -helix,  $\beta$ -sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of protein-folding and domain structure. Quaternary structure. Amino acid metabolism-degradation and biosynthesis of amino acids, sequence determination :

chemical/enzymatic/mass spectral, racemization/detection. Chemistry of oxytocin and tryptophan releasing hormone (TRH).

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## Unit-V

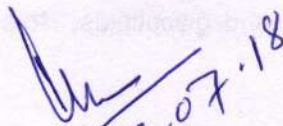
### Nucleic Acids

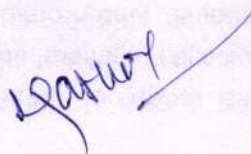
Purine and pyrimidine bases of nucleic acids, base pairing via Hbonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA), double helix model of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis for heredity, an overview of replication of DNA, transcription, translation and genetic code. Chemical synthesis of mono and trinucleoside.

### Book Suggested

1. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
2. Biochemistry, L. Stryer, W.H. Freeman.
3. Biochemistry, J. David Rawan, Neil Patterson.
4. Biochemistry, Voet and Voet, John Wiley.
5. Outlines of Biochemistry E.E. Conn and P.K. Stumpf, John Wiley.

  
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## PRACTICAL

(Duration: 6-8 hrs in each branch)

Practical examination shall be conducted separately for each branch.

### Inorganic Chemistry

#### SEMESTER I

Quantitative and quantitative Analysis	12
Preparation	12
Record	4
Viva Voce	5

#### Qualitative and Quantitative Analysis

- Quantitative determinations of a three component mixture
- Insoluble- Oxides, sulphates and halides.
- Less common metal ions : Ti, Mo, W, Ti, Zr, Th, V, U (two metal ions in cationic/anionic forms).
- Quantitative separation and determination of the following pairs of metal ions using gravimetric and volumetric methods:
  - $\text{Cu}^{2+}$  (gravimetrically) and  $\text{Zn}^{2+}$  (volumetrically),
  - $\text{Fe}^{3+}$  (gravimetrically) and  $\text{Ca}^{2+}$  (volumetrically)
  - $\text{Cu}^{2+}$  (gravimetrically) and  $\text{Ni}^{2+}$  (volumetrically)
  - $\text{Ni}^{2+}$  (gravimetrically) and  $\text{Zn}^{2+}$  (volumetrically)
  - $\text{Cu}^{2+}$  (gravimetrically) and  $\text{Fe}^{3+}$  (volumetrically)

#### Preparations

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

- trans-potassium diaquabis(oxalato)chromate(III),  $\text{trans-K}[\text{Cr}(\text{ox})_2(\text{H}_2\text{O})_2]$
- cis-potassium diaquabis(oxalato)chromate(III),  $\text{cis-K}[\text{Cr}(\text{ox})_2(\text{H}_2\text{O})_2]$
- $\text{Na}[\text{Cr}(\text{NH}_3)_2(\text{SCN})_4]$
- $\text{Ni}(\text{acac})_2$
- $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$
- Prussian Blue, Turnbull's Blue.
- Potassium tri-oxalato aluminate

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## ORGANIC CHEMISTRY

### SEMESTER I

#### Organic Chemistry

Qualitative Analysis	16
Organic Synthesis	08
Record	4
Viva Voce	5

#### Qualitative Analysis

Separation, purification and identification of compounds of ternary mixture.

#### Organic Preparation

Acetylation: Acetylation of salicylic acid

Benzoylation of Glycine

Oxidation of benzil to benzilic acid

The Products may be Characterized by Spectral Techniques.

### SEMESTER I

#### Physical Chemistry

Error Analysis and Statistical Data Analysis	8
Chemical Kinetics	9
Solution	8
Record	4
Viva Voce	5

#### Error Analysis and Statistical Data Analysis

1. Errors, types of errors, minimization of errors distribution curves precision, accuracy and combination; statistical treatment for error analysis, t test, null hypothesis, rejection criteria. F & Q test; linear regression analysis, curve fitting.
2. Calibration of volumetric apparatus, burette, pipette and standard flask.
3. Preparation of standard solutions (solid and liquid compounds) and their standardization
4. Equalization of strength of two acids by titrimetrically

#### Chemical Kinetics

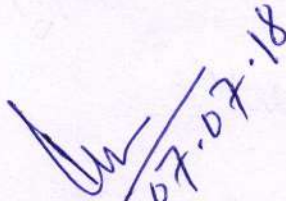
Determination of the effect of (a) Change of temperature (activation parameters) (b) Change of concentration of reactant and catalyst and (c) Ionic strength of the media on the velocity constant of

1. Acid catalyzed hydrolysis of an ester
2. Sodium-formate-I<sub>2</sub> reaction

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## Solution

1. Determination of congruent composition and temperature of a binary system (e.g. diphenylamine-benzophenone system).
2. Determination of molecular weight of camphor by Rast method

## Books Suggested

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.
2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly. Prentice Hall.
3. Experiments and Techniques in Organic Chemistry, D.P. Pasto, C. Johnson and M. Miller, Prentice Hall.
4. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Health.
5. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
6. Handbook of Organic Analysis-qualitative and Quantitative. H. Clark, Adward Arnold.
7. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
8. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
9. Findley's Practical Physical chemistry, B.P. Levitt, Longman.
10. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.
11. Inorganic Experiments, J. Derek Woolings, VCH.
12. Microscale Inorganic Chemistry, Z. Szafran, R.M. Pike and M.M. Singh, Wiley.
13. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Van Nostrad.
14. The systematic Identification of Organic Compounds, R.L. Shriner and D.Y. curlin.

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2018-19

## SEMESTER II

Paper-I

MCH-201: INORGANIC CHEMISTRY II

(5 credits)

### Unit-I

#### Electronic Spectral Studies of Transition Metal Complexes :

Spectroscopic ground states, Correlation. Orgel and Tanabe-Sugano diagrams for transition metal complexes ( $d^1$ - $d^9$  states), Electronic Spectral Studies for  $d^1$  -  $d^9$  systems in octahedral, tetrahedral and square planer complexes, Selection rule for electronic spectroscopy. Intensity of various type electronic transitions, Calculations of  $10Dq$ ,  $B$  and  $\beta$  parameters, effect of distortion on the d-orbital energy levels. Structural evidence from electronic spectrum, Jahn-Teller effect, Spectrochemical and nephelauxetic series, charge transfer spectra

### Unit-II

#### Magnetic Properties of Transition Metal Complexes

Origin of magnetism, types of magnetism, Curie law, Curie-Weiss Law, Magnetic properties of complexes-paramagnetism, quenching of orbital angular momentum by ligand fields, Magnetic properties of A, E & T ground terms in complexes, spin free- spin paired equilibria, Guoy's method for determination of magnetic susceptibility, calculation of magnetic moments, magnetic properties of free ions, orbital contribution, effect of ligand-field, Anomalous magnetic moments, magnetic exchange coupling and spin state cross over.

### Unit-III

#### Metal $\pi$ -Complexes

Metal carbonyl, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding structure and important reaction of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand

### Unit-IV

#### Metal Clusters

Structure and bonding in higher boranes, styx coding, Wade's rules, Carboranes, metalboranes and metallo-carboranes compounds with metal metal multiple bonds. Metal Carbonyl clusters- Low Nuclearity Carbonyl clusters, High Nuclearity Carbonyl clusters, total electron count (TEC), Halide type Clusters, Chevrel phases, Naked clusters

### Unit-V

#### Optical Rotatory Dispersion and Circular Dichroism

Linearly and circularly polarized lights; optical rotatory power and circular birefringence, ellipticity and circular dichroism; ORD and Cotton effect, Faraday and Kerr effects; Assignment of electronic transitions; applications of ORD and CD for the determination of (i) absolute configuration of complexes and (ii) isomerism due to non-planarity of chelate rings

  
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**Books Suggested :**

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
3. Chemistry of the Elements. N.N. Greenwood and A. Earnshaw, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
5. Magnetochemistry, R.1. Carlin, Springer Verlag.
6. Comprehensive Coordiantion Chemistry eds., G. Wilkinson, R.D. Gillars and J.A. Mc Cleverty, Pergamon.

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Paper-II

MCH-202: ORGANIC CHEMISTRY II

(5 credits)

### Unit-I

#### Aromatic Electrophilic Substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeier reaction, Gatterman-Koch reaction

#### Aromatic Nucleophilic Substitution

The S<sub>N</sub>Ar, S<sub>N</sub>1, benzyne and S<sub>RN</sub>1 mechanism, Reactivity effect of substrate structure, leaving group and attacking nucleophile. The Von Richter, Sommelet-Hauser, and Smiles rearrangements.

### Unit-II

#### Free Radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, autooxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts, Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction, Oxidation by peracids, Fenton's reagent, Elbs reaction.

### Unit III

#### Addition to Carbon-Carbon double bonds

Mechanism and stereochemistry of addition reactions involving electrophiles, nucleophiles and free radicals, orientation and reactivity, cyanoethylation. Addition to conjugated systems. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings, Birch reduction. Hydroboration, Michael reaction, Sharpless asymmetric epoxidation.

### Unit-IV

#### Addition to Carbon-Hetero Multiple bonds

Mechanism of reduction of LAH and NaBH<sub>4</sub> of saturated and unsaturated carbonyl compounds, acids, esters and nitriles, chemoselectivity.

Addition of Grignard reagents, organozinc and organolithium reagents to saturated and unsaturated carbonyl compounds.

#### Elimination Reactions

The E<sub>2</sub>, E<sub>1</sub> and E<sub>1cB</sub> mechanisms and their spectrum. Orientation of the double bond. Reactivity-effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

  
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## Unit-V

### Organic Reactions and Reagents:

**Reactions with mechanism and synthetic applications:** Stork Enamine, Haller-Bauer, Houben-Hoesch, Shapiro, Stobbe, Wittig, Swern oxidation, Hoffman-Loffler-Freytag reactions, Di-Pi methane rearrangement, Dienone-phenol rearrangement.

**Preparations of reagents and their synthetic applications:** Lithium diisopropyl amide (LDA), Osmium tetra-oxide ( $\text{OsO}_4$ ), Lead tetra acetate (LTA), Dicyclo hexylcarbodiimide (DCC), 1,3-dithiane, Lithium dialkyl cuprate, Pyridinium chlorochromate(PCC), Jone's and Collin reagents, Wilkinson's catalyst.

### Book Suggested

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentice-Hall.
6. Modern Organic Reactions, H.O. House, Benjamin.
7. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
8. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
9. Organic name reactions(A Unified approach), Goutam Brahmachari, Narosa Publishing House, New-Delhi.
10. Stereochemistry of Organic Compounds, D.Nasipuri, New Age International.
11. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.
12. Some Modern Methods of Organic Synthesis. W. carruthers, Cambridge Univ. Press
13. Modern Methods of Organic Synthesis Normon-Coxan
14. Reaction Mechanism in Organic Chemistry, P.S. Kalsi, New age international, New- Delhi.

Paper-III

MCH-203: PHYSICAL CHEMISTRY II

(5 credits)



**Unit-I****Chemical Dynamics**

Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, homogenous catalysis, Dynamic chain reactions (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical chain reactions (Hydrogen Bromine and hydrogen-Chlorine ), kinetics of enzyme catalysed reactions,

general features for fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method,

treatment of unimolecular reactions. dynamics of unimolecular reactions (Lindemann Hinshelwood and Rice-Ramsperger-Kassel- Marcus (RRKM) theories for unimolecular reactions).

**Unit-II****Surface Chemistry and Micelles**

Surface tension, surface energy, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), Surface films on liquids (Electro-kinetic phenomenon).

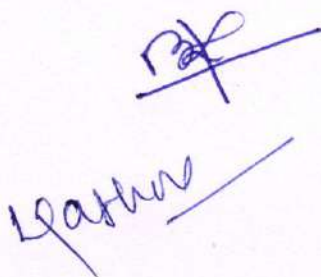
Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass action models, solubilization, micro emulsion, reverse micelles. Applications of micelles.

**Unit-III****Polymer Chemistry**

Polymer-definition, types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization. Molecular mass, number and mass average molecular mass, molecular mass determination (Osmometry, viscometry, diffusion and light scattering methods), sedimentation, chain configuration of macromolecules, calculation of average dimension of various chain structures.

**Unit-IV****Non Equilibrium Thermodynamics**

Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (e.g., heat flow, chemical reaction etc.) transformations of the generalized fluxes and forces, non equilibrium stationary states, phenomenological equations, microscopic reversibility and Onsager's reciprocity relations, electrokinetic phenomena, diffusion, electric conduction.




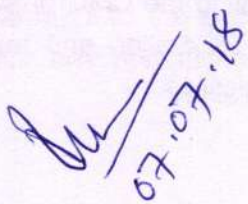
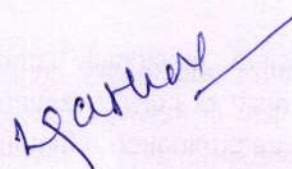
## Unit-V

### Electrochemistry

Electrochemistry of solutions. Debye-Huckel-Onsager treatment and its extension, ion solvent interactions. Debye-Huckel-Jerum mode, Thermodynamics of electrified interface equations, Derivation of electro capillarity, Lippmann equations (surface excess), methods of determination, Structure of electrified interfaces, Overpotentials, exchange current density, derivation of Butler Volmer equation, Tafel plot, Quantum aspects of charge transfer at electrodes-solution interfaces, electrolyte solution interfaces, quantization of charge transfer, tunneling. Semiconductor interfaces-theory of double layer at semiconductor, structure of double layer interfaces, Effect of light at semiconductor solution interface.

### Books Suggested

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Introduction to Quantum Chemistry, A.K. Chandra, Tata Mc Graw Hill.
3. Quantum Chemistry, Ira N. Levine, Prentice Hall.
4. Coulson's Valence, R. Mc Ween y, ELBS.
5. Chemical Kinetics. K. J. Laidler, McGraw-Hill.
6. Kinetics and Mechanism of Chemical Transformation J. Rajaraman and J. Kuriacose, Mc Millan.
7. Micelles, Theoretical and Applied Aspects, V. M. Ornoi, Plenum.
8. Modern Electrochemistry Vol. 1 and Vol II J.O.M. Bockris and A.K.N. Reddy, Plenum.
9. Introduction to Polymer Science, V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar, Wiley Eastern.

## Paper-IV

### MCH-204: Spectroscopy II and Diffraction Methods

(5 credits)

#### Unit-I

##### Nuclear Magnetic Resonance Spectroscopy

Spin-spin interactions, factors influencing coupling constant "j" Classification (AXB, AMX, ABC, A2B2 etc.). spin decoupling, NMR studies of nuclei other than proton-<sup>13</sup>C, <sup>19</sup>F and <sup>31</sup>P.

##### Nuclear Quadrupole Resonance Spectroscopy

Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant, splitting. Applications.

#### Unit-II

##### Electron Spin Resonance Spectroscopy

Basic principles, zero field splitting and Kramer's degeneracy, factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants, spin Hamiltonian, spin densities and Mc Connell relationship, measurement techniques, applications.

#### Unit III

##### Surface Spectroscopies

Vibrational studies of surfaces, EELS, RAIRS, Raman Spectroscopy, Photoelectron Spectroscopy, Basic principles, photo-electric effect, ionization process, Koopman's theorem. Photoelectron spectra of simple molecules, ESCA, chemical information from ESCA. Auger electron spectroscopy, X-Ray Fluorescence, Structural Methods: EXAFS, SEXAFS,

#### Unit-IV

##### X-ray Diffraction

Bragg condition; Miller indices, Laue Method, Bragg method, Debye Scherrer method of X-ray structural analysis of crystals, index reflections, identification of unit cells from systematic absences in diffraction pattern, Structure of simple lattices and X-ray intensities, structure factor and its relation to intensity and electron density, phase problem. Description of the procedure for an X-ray structure analysis, absolute configuration of molecules.

#### Unit-V

##### Electron Diffraction



Scattering intensity vs. scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules. Low energy electron diffraction and structure of surfaces.

**Neutron Diffraction** Scattering of neutrons by solids measurement techniques, Elucidation of structure of magnetically ordered unit cells.



### Books suggested

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Applied Electron Spectroscopy for chemical analysis d. H. Windawi and F.L. Ho, Wiley Interscience.
3. NMR, NQR, EPr and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. , Ellis Harwood.
4. Physical Methods in Chemistry, R.S. Drago, Saunders College.
5. Chemical Applications of Group Theory, F.A. Cotton.
6. Introduction to Molecular Spectroscopy, G.M. Barrow, Mc Graw Hill.
7. Basic Principles of Spectroscopy, R. Chang, Mc Graw Hill.
8. Theory and Application of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBHOxford.
9. Introduction to Photoelectron Spectroscopy, P.K. Ghosh, John Wiley.
10. Introduction to Magnetic Resonance. A Carrington and A.D. Maclachalan, harper & Row.

  
  
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**Paper-V**

**MCH-205: COMPUTERS FOR CHEMISTS**

**(4 credits)**

**UNIT-I**

Basic structure and functioning of computer, Memory I/O devices. Secondary storages, Computer languages, Operating systems with DOS as an example, Introduction to UNIX and WINDOWS.

**Basics of Programming:** Algorithms, Flowcharts, Introduction to Programming Languages, Assembler, Compiler, Interpreter, Features of High Level Programming Languages, Procedure Oriented Programming Language, History and Importance of C, Structure of C Program.

**UNIT-II**

**Programming with C:** Character Set, Identifiers, Keywords, Variables, Character Strings, Qualifiers, Typecasting, Constants, Operator and Expression, Operator Precedence and Associativity, Input-Output Statements.

Control Statements: if, if-else, nested if, if-else ladder, switch Statements, Loops: for, while do-while, break and continue statement, Arrays, Strings.

**UNIT-III**

Functions: Why function? Structured Programming, Parameter Passing: call by value, call by reference, return values, recursion v/s iteration, scope extent, passing arrays and function to functions.

**UNIT-IV**

Developing of small computer codes involving simple formulae in Chemistry such as Van der Waals equation, Chemical kinetics (determination of Rate constant), Radioactive decay (Half Life and Average Life), Determination of Normality, Molarity and Molality of solutions, Evaluation of Electronegativity of atom and Lattice Energy from experiment, determination of molecular weight and percentage of element organic compounds using data from experimental, metal representation of molecules in terms of elementary structural features such as bond lengths, bond angles, dihedral angles, etc.

**UNIT-V**

Computer Software in Chemistry: Instrument Control, Instrument Maintenance and Calibration system, Graphical Display of Data and Molecular Structures, Chem Office, Chemdraw, Chemistry 4-D Draw Standard.

Introduction to Internet, Application of Internet for Chemistry, Search Engine, Net Protectors and E-mail version.

**Reference Books**

1. Computers and Their Applications to Chemistry by Ramesh Kumari, Narosa Publication
2. Let Us C by Y. Kanetkar, BPB Publication
3. Programming in C by E. Balaguruswamy

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## SEMESTER II

### Inorganic Chemistry

Chromatography	12
Preparation	12
Record	4
Viva Voce	5

**Chromatography** Separation of cations and anions by Column Chromatography : Ion exchange.

- To determine the ion exchange capacity of cation exchangers
- To determine the ion exchange capacity of anion exchangers
- Ion – exchange chromatography; Separation & estimation of ( $Zn^{+2}/ Cd^{+2}$ ) & ( $Zn^{+2} / Mg^{+2}$ ) in mixtures using Amberlite IRA 400 anion exchanger
- To determine the total cation concentration of given sample of water by ion exchange in ppm.

### Preparations

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

- $[Co(NH_3)_6][Co(NO_2)_6]$
- $Hg[Co(SCN)_4]$
- $[Co(Py)_2Cl_2]$
- $[Ni(NH_3)_6]Cl_2$
- $Ni(dmg)_2$
- $[Cu(NH_3)_4]SO_4 \cdot H_2O$
- $[Cr(NH_3)_6]Cl_3$
- Reinecke's salt.

## SEMESTER II

### Organic Chemistry

Organic Synthesis	12
Quantitative Analysis	12
Record	4
Viva Voce	5

### Organic Synthesis

Claisen Schmidt reaction: Dibenzal acetone from benzaldehyde.

Sandmeyer reaction : p- Chlorotoluene from p-toluidine.

Acetoacetic ester Condensation : Synthesis of ethyl-n-butylacetoacetate by A.E.E. condensation.

Cannizzaro reaction : 4-Chlorobenzaldehyde as substrate.

Friedel Crafts reaction : b-Benzoyl propionic acid from succinic anhydride and benzene.

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Aromatic electrophilic substitutions : Synthesis of p-nitroaniline and p-bromoaniline.  
The Products may be Characterized by Spectral Techniques.

### Quantitative Analysis

Determination of iodine and Saponification values of an oil sample.

Determination of DO, COD and Hardness of water sample.

## SEMESTER II

### Physical Chemistry

Conductometry	12
Potentiometry/pH metry/ Polarimetry	13
Record	4
Viva Voce	5

#### Conductometry

1. To find out the strength of HCl solution by titrating against standard NaOH solution conductometrically
2. To find out the strength of HAc solution by titrating against standard NaOH solution conductometrically
3. To find out the strength of HCl and HAc in a mixture of both by titrating against standard NaOH solution conductometrically

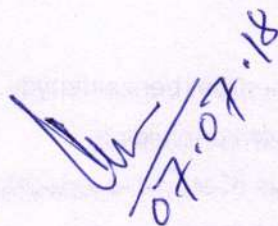
#### Potentiometry/pH metry

1. Estimation of halides ( $\text{Cl}^-$ ,  $\text{Br}^-$  and  $\text{I}^-$ ) single ions and in a mixture potentiometrically.
2. Determination of the strength of strong and weak acids in a given mixture using pH meter.
3. Acid-base titration in a non-aqueous media using a pH meter.
4. Determination of activity and activity coefficient of electrolytes.
5. Determination of the dissociation constant of monobasic/polybasic acid by titrating against standard NaOH solution.

#### Polarimetry

1. Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter.
2. Enzyme kinetics-inversion of sucrose.

  
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### Books Suggested

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.
2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall.
3. Experiments and Techniques in Organic Chemistry, D.P. Pasto, C. Johnson and M. Miller, Prentice Hall.
4. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Health.
5. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
6. Handbook of Organic Analysis-qualitative and Quantitative. H. Clark, Adward Arnold.
7. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
8. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
9. Findley's Practical Physical chemistry, B.P. Levitt, Longman.
10. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.
11. Inorganic Experimens, J. Derek Woolings, VCH.
12. Microscale Inorganic Chemistry, Z. Szafran, R.M, Pike and M.M. Singh, Wiley.
13. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Van Nostrad.
14. The systematic Identification of Organic Compounds, R.L. Shriner and D.Y. curlin.



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**SEMESTER III**

**Paper-I**

**MCH-301: APPLICATIONS OF SPECTROSCOPY I**

**(5 credits)**

**Unit I**

**Electronic Spectroscopy**

Electronic Spectral Studies for  $d^1$  -  $d^9$  systems in octahedral, tetrahedral and square planer complexes, calculation of Crystal Field parameters, interelectronic repulsion parameter and bonding parameters.

**Unit II**

**Vibrational Spectroscopy**

Symmetry aspects of molecular vibrations of  $H_2O$  molecule. Application of Group theory to Infrared Spectroscopy: Introduction, selection rules, symmetry of vibrations and their IR activity, Group vibration concept and its limitations.

Symmetry and shapes of  $AB_2$ ,  $AB_3$ ,  $AB_4$ ,  $AB_5$  and  $AB_6$ , mode of bonding of ambidentate ligands, nitrosyl, ethylenediamine and diketonato complexes, application of Resonance Raman spectroscopy and its applications.

**Unit III**

**Nuclear Magnetic Resonance Spectroscopy-I**

Mechanism of measurement of chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), Chemical exchange, effect of deuteration, Complex spin spin interaction between two and three (I order spectra), Stereochemistry, hindered rotation, Karplus curve-variation of coupling constant with disordered angle. NMR shift reagents, solvent effects. nuclear overhauser effect (NOE).

**Unit IV**

**Nuclear Magnetic Resonance Spectroscopy-II**

Carbon-13 NMR Spectroscopy, General considerations, instrumental difficulties, FT technique, advantages and disadvantages. Proton Noise Decoupling technique, off-resonance technique, Chemical shifts of solvents, factors affecting chemical shifts, analogy with  $^1H$  NMR, calculations of chemical shift of hydrocarbons, effect of substituents on chemical shifts, different types of carbons (alkene, alkyne and allene), chemical shift of aromatic carbons and effect of substituent. Chemical shifts of carbonyl, nitrile, oxime carbons.

**Unit V**

**Mössbauer Spectroscopy** Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of  $Fe^{+2}$  and  $Fe^{+3}$  compounds including those of intermediate spin, (2)  $Sn^{+2}$  and  $Sn^{+4}$  compounds nature of M-L bond, coordination number, structure and (3) detection of oxidation state and inequivalent MB atoms.

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**Books Suggested:**

1. Physical Methods for Chemistry, R.S. Drago, Saunders Compnay.
2. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS.
3. Infrared and Raman Spectral : Inorganic and Coordination Compounds K. Nakamoto, Wiley.
4. Progress in Inorganic Chemistry vol., 8, ed., F.A. Cotton, vol., 15 ed. S.J. Lippard, Wiley.
5. Transition Metal Chemistry ed. R.L. Carlin vol. 3 dekker.
6. Inorganic Electronic Spectroscopy, A.P.B. Lever, Elsevier.
7. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, .V. Parish, Ellis Haywood.
8. Practical NMR Spectroscopy, M.L. Martin. J.J. Deepish and G.J. Martin, Heyden.
9. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler adn T.C. Morrill, John Wiley.
10. Introduction to NMR spectroscopy, R.J. Abraham, J. Fisher and P. Loftus, Wiley.
11. Application of Spectroscopy of Organic Compounds, J.R. Dyer Prentice Hall.
12. Spectroscopic Methods in Organic Chemistry D.H. Williams, I. Fleming, Tata McGraw-Hill.
13. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS.
14. Introduction to NMR spectroscopy, R.J. Abraham, J. Fisher and P. Loftus, Wiley.

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**Paper-II**

**MCH-302: PHOTOCHEMISTRY AND PERICYCLIC REACTIONS**

**(5 credits)**

**Unit I**

Interaction of electromagnetic radiation with matter (Dual nature of light and matter) types of excitations, singlet and triplet states, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

**Determination of Reaction Mechanism**

Classification, rate constants and life times of reactive energy state, determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions, photoreduction.

**Unit II**

**Photochemistry of Alkenes**

Cis-trans isomerization, inter and intramolecular cyclisation reactions, Photochemistry of butadiene, Rearrangement of 1,4-(di- $\pi$  rearrangement), 1,5- 1,6- and 1,7-dienes.

**Photochemistry of Aromatic Compounds**

Isomerisations, additions and substitutions.

**Unit III**

**Photochemistry of Carbonyl Compounds**

Reactions of carbonyl compounds-saturated, cyclic, acyclic and  $\alpha$ ,  $\beta$ - unsaturated compounds, Intermolecular cycloaddition reactions-dimerisations and oxetane formation.

**Miscellaneous Photochemical Reactions**

Barton reaction, Singlet molecular oxygen-structure, methods of generation and its reaction.

**Unit IV**

**Pericyclic Reactions-I**

Molecular orbital symmetry, HOMO and LUMO, Ground state and excited state electronic configurations of a conjugated diene, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system.

**Electrocyclic reactions**

Conrotatory and disrotatory modes, Woodward-Hoffmann rules.

FMO and PMO approaches: Thermal and photochemical reactions of 4 and 4+2 systems (1,3-Butadiene and 1,3,5 – hexatriene), correlation diagrams.

**Unit V**

**Pericyclic Reactions-II**

**Cycloaddition Reactions**

FMO approach, antarafacial and suprafacial additions, Molecular orbitals of ethylene, [2+2] and Diels-Alder [4+2] cycloadditions, endo and exo product, stereochemical rule, 1,3 dipolar cycloadditions.

**Sigmatropic rearrangements**

Suprafacial and antarafacial shifts of H, 1,3-, 1,5- and 1,7- sigmatropic H shift, Claisen, and Cope rearrangements, Ene reaction.

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### Books Suggested

1. Fundamentals of photochemistry, K.K. Rothagi-Mukheriji, Wiley-Eastern.
2. Essentials of Molecular Photochemistry, A Gilbert and J. Baggott, Blackwell Scientific Publication.
3. Molecular Photochemistry, N.J. Turro, W.A. Benjamin.
4. Introductory Photochemistry, A. Cox and T. Camp, McGraw Hill.
5. Photochemistry, R.P. Kundall and A. Gilbert. Thomson Nelson.
6. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.

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**Unit I**

**The Structure of solids**

The types of matter, classification of solids, close packing of atoms; Voids in closest packings; Radius ratio rule, Structure of ionic Crystals; Ionic Crystals with stoichiometry  $MX$ , Ionic Crystals with stoichiometry  $MX_2$ , spinel structure, inverse spinel, perovskite structure.

**Unit II**

**Solid State reactions and Crystal Growth**

Classification of solid state reactions and their kinetics and mechanisms, thermal decomposition reaction, Nucleation, Reaction between two solids, Improving the reactivity of solids, Methods and theories of crystal growth, Zone refining method

**Unit III**

**Crystal Defects and Non-Stoichiometry**

Perfect and imperfect crystals, intrinsic and extrinsic defects-point defects, line and plane defects, vacancies-Schottky defects and Frenkel defects, Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry defects, Surface imperfections.

**Unit IV**

**Electronic Properties and Band Theory**

Metals insulators and semiconductors, electronic structure of solids, band theory band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, superconductors.

Optical properties-Application of optical and electron microscopy

Magnetic Properties-Classification of materials: Effect of temperature calculation of magnetic moment, mechanism of ferro and anti ferromagnetic ordering super exchange.

**Unit V**

**Organic Solids and Liquid Crystals**

Electrically conducting solids, organic charge transfer complex, organic metals, new superconductors. Types of liquid crystals: Nematic, Smectic, Ferroelectric, Antiferroelectric, Various theories of LC, Liquid crystal display, New materials.

Books Suggested.

1. Solid state chemistry and its applications, A.R. West. Peenum.
2. Principles of the Solid State, H.V. Keer, Wiley Eastern.
3. Solid State Chemistry, N.B. Hannay.
4. Solid State Chemistry, D.K. Chakrabarty, New Wiley Eastern.

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## ELECTIVE PAPERS

Out of the following select any two papers each of marks 50:

### Discipline centric

OPT-1 MCH-304A Polymers

OPT-2 MCH-304B Heterocyclic Chemistry

OPT-3 MCH-304C Bioorganic Chemistry

OPT-4 MCH-304D Biophysical Chemistry

OPT-5 MCH-304E Bioinorganic Chemistry

OPT-6 MCH-304F Electrochemistry

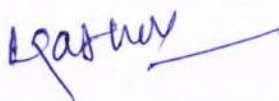
### Interdisciplinary

OPT-1 MCH-304G Environmental Chemistry





  
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**Unit I****Basics**

Importance of polymers, Basic concepts: Monomers, repeat units, degree of polymerization Linear, branched and network polymers, Classification of polymers, Polymerization: condensation, addition/radical chain-ionic and co-ordination and copolymerization, Polymerization conditions and polymer reactions, Polymerization in homogeneous and heterogeneous systems

**Unit II****Polymer Characterization**

Polydispersion-average molecular weight concept, Number, weight and viscosity average molecular weights, Polydispersity and molecular weight distribution, The practical significance of molecular weight, Measurement of molecular-weights, End-group, viscosity, light scattering, osmotic and ultracentrifugation methods.

**Unit III****Analysis and testing of polymers**

Chemical analysis of polymers, spectroscopic methods, X-ray diffraction study, Microscopy, Thermal analysis and physical testing-tensile strength, fatigue, impact, tear resistance, Hardness and abrasion resistance.

**Unit IV****Polymer Processing**

Plastics, elastomers, fibers, Compounding, Processing techniques. Clendering, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming, reinforcing and fire spining

**Unit V****Structure, Properties and Application of Polymers**

Functional polymers: Fire retarding polymers and Electrically conducting polymers.

Biomedical polymers: Contact lens, dental polymers, artificial heart and kidney

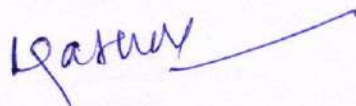
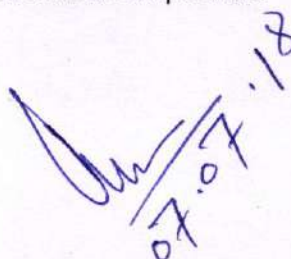
Polymers based on boron-borazines, boranes and carboranes.

Polymers based on Silicon, silicone's polymetalloxanes, polymetallosiloxanes and silazanes.

Polymers based on Phosphorous-Phosphazenes, Polyphosphates

Polymers based on Sulphur-Tetrasulphur tetranitride and related compounds.

Co-ordination and metal chelate polymers.







**Unit I****Nomenclature of Heterocycles**

Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic fused and bridged heterocycles.

**Aromatic Heterocycles**

General chemical behaviour of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in  $^1\text{H}$  NMR-spectra. Empirical resonance energy, delocalization energy and Dewar resonance energy, diamagnetic susceptibility exaltations). Heteroaromatic reactivity and tautomerism in aromatic heterocycles.

**Unit II****Non-aromatic Heterocycles**

Strain-bond angle and torsional strains and their consequences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction. Stereo-electronic effects anomeric and related effects, Attractive interactions-hydrogen bonding and intermolecular nucleophilic electrophilic interactions. Heterocyclic synthesis-principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reactions.

**Unit III****Small Ring Heterocycles**

Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, thiranes, azetidines, oxetanes and thietanes.

**Benzofused five membered heterocycles**

Synthesis and reactions including medicinal applications of benzopyrroles, bezofurans and benzothiophenes.

**Five membered heterocycles**

Synthesis and reactions including medicinal applications of Imidazoles, oxazoles and thiazoles.

**Unit IV****Meso-ionic Heterocycles**

General introduction and classification of meso-ionic heterocycles, Chemistry of 1,3-oxazolium-4-olates, 1,3-oxathiolium-5-olates and 1,2-diazolium-4-aminides.

**Six-Membered Heterocycles**

Synthesis and reactions of coumarins and chromones. General structure and synthesis of anthocyanidins

**Two or More Heteroatoms heterocycles:** Synthesis and reactions of diazines, triazines.

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## Unit V

### Seven-and Large-Membered Heterocycles:

Synthesis and reactions of azepines, oxepines, thiepinines, diazepines, and thiazepines.

### Heterocyclic Systems Containing P, As, Sb and B

Heterocyclic rings containing phosphorus: Introduction, nomenclature, synthesis and reactions of 5-membered ring systems. Heterocyclic rings containing As and Sb : Introduction, synthesis and characteristics of 5- and 6-membered ring system. Heterocyclic rings containing B : Introduction, synthesis and reactivity of 5- and 6- membered ring system.

### Books suggested

1. Heterocyclic Chemistry Vol. 1-3, R.R. Gupta, M. Kumar and V.Gupta, Springer Verlag.
2. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
3. Heterocyclic chemistry J.A. Joule, K. Mills and g.F. Smith, Chapman and Hall.
4. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scietific Techinal.
5. Contemporary Hetrocyclic Chemistry, G.R. Newkome and W.W. Paudler, Wiley-Inter Science.
6. An Introductiion to the Heterocyclic Compounds, R.M. Acheson, Johnwiely.
7. Comprehensive Heterocyclic Chemistry, A.R. Katrizky and C.W. Rees, eds. Pergamon Press.

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## MCH-304C BIOORGANIC CHEMISTRY

(5 credits)

### Unit I

**Carbohydrate Metabolism:** Glycolysis, Glycogenesis, glycogenolysis, Gluconeogenesis, metabolism of galactose, pentose phosphate pathway, Citric acid cycle: reactions, energetic and its significance.

**Lipid Metabolism:** Oxidation of fatty acids, alpha, Beta and omega oxidation.

### Unit II

#### Biosynthesis of organic compounds

Amino acids: Shikimic acid route leading to chorismic acid to L-phenyl alanine and tryptophan, glutamate family: 2-oxoglutaric acid to L-proline, oxaloacetic acid to L-asparagine.

Terpenoids: Mevalonate pathway, acyclic (citronellal), monocyclic monoterpenoids (limonene,  $\alpha$ -terpinene and  $\alpha$ -terpineol), bicyclic monoterpene ( $\alpha$ -pinene), sesquiterpene (cadinene) and squalene.

Carotenoids, cholesterol (from squalene) and flavonoids (quercetin and cyanidin)

Alkaloids: ephedrine (from phenyl alanine), quinine (from tryptophan)

### Unit III

#### Enzymes

**Enzymes:** Introduction, Nomenclature and classification, Remarkable properties of enzymes, concept and identification of active site by use of inhibitors, reversible & irreversible inhibition, Michaelis-Menten and Lineweaver-Burk plot.

#### Kinds of Reactions Catalyzed by Enzymes:

B-cleavage and condensation, some isomerization and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.

Mechanism of Enzyme action: Transition state theory, acid-base catalysis, covalent catalysis.

#### Co-Enzyme Chemistry:

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes, Structure and biological functions of coenzyme A.

### Unit IV

#### Enzyme Models

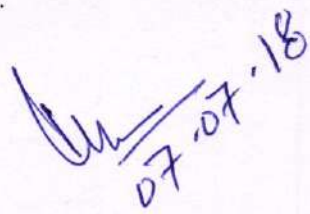
Host guest chemistry, Chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality, Biomimetic chemistry, crown ethers, cryptates, cyclodextrins, cyclodextrin based enzyme models, Calixarenes, ionophores, micelles synthetic enzyme or synzymes.

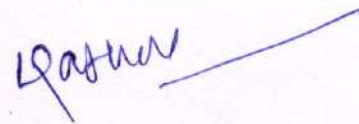
#### Biotechnological Application of enzymes:

Techniques and methods of immobilization of enzyme activity, application of immobilized enzymes, clinical uses of enzymes and recombinant DNA technology.









## Unit V

### Proteins and nucleic acids

Classification, physical and chemical properties of amino acids, Structure of protein and stabilizing factors– primary, secondary, tertiary and quaternary structure of protein.

Structure of purines, pyrimidines, nucleosides and nucleotides. General structural plan of nucleic acids, features of DNA double helix.

Transcription – RNA polymerase, promoters, initiation elongation and termination of RNA synthesis, inhibitors of transcription, Reverse transcriptase. Genetic code – basic features, biological significance, degeneracy, wobble hypothesis.

Translation – Mechanism, structure of ribosome, various steps involved in translation – initiation, elongation and termination, inhibitors of translation.

### Book Suggested

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, 1. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
3. Inorganic biochemistry vol. I and II ed. G.L. Eichhorn, Elsever.
4. Progress in Inorganic Chemistry, Vol 18 and 38 ed J.J. Lippard, Wiley.
5. Bioorganic Chemistry : A chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer Verlag.
6. Understanding Enzymes, Trevor Palmer, Prentice Hall.
7. Enzyme Chemistry : Impact and applications, Ed. Collin J suckling, chemistry.
8. Enzyme Mechanisms Ed. M.I. Page and A Williams, Royal Society of Chemistry.
9. Fundamentals of Enzymology, N.C. Price and L. Stevens. Oxford University Press.
10. Immobilized Enzymes : An Introduction and Applications in Biotechnology, Michael ID. Trevan, Hohn Wiley.
11. Enzymatic Reaction Mechanisms. C. Walsh. W.H. Freeman.
12. Enzyme Structure and Mechanism, A Fersht, W.H. Freeman
13. Biochemistry : The Chemical Reactions of Living Cells, D.E. Metzler, Academic Press.
14. Concepts in biotechnology by D. Balasubramanian & others\
15. Principals of biochemistry by Horton & others.
16. Bioorganic chemistry - A chemical approach to enzyme action by Herman Dugas and Christopher Penney.
17. Organic Chemistry, Volume 2: Stereochemistry And The Chemistry Natural Products, I. L. Finar, Pearson Education of India.
18. Principles and techniques of Biochemistry and Molecular Biology, Keith Wilson and John Walker, Cambridge University Press
19. Bioorganic, Bioinorganic and Supramolecular Chemistry, P. S. Kalsi, J. P. Kalsi, New Age International Publishers
20. Bioorganic Chemistry , G. R. Chatwal, Himalaya Publishing House

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## MCH-304D BIOPHYSICAL CHEMISTRY

(5 credits)

### UNIT I

Biological cell and its constituents, Biomembrane, Various models of biomembrane, Fick's law, Active and Passive transport, Carrier mediated ion transport, Irreversible thermodynamic treatment to the membrane transport, Exergonic and Endergonic reactions, Mechanism of signal transduction, Nerve conduction, Standard free energy in biochemical reactions

### UNIT II

Ions, ion solvation, acidity of solution, acidic and basic properties of amino acids, intermolecular forces in natural and synthetic polymers, Helix coil transition.

Non covalent interactions, Biomimetic agents, Surfactants, vesicles, Host-guest system, Drug-receptor interaction, Application of membrane mimetic agents, enzyme model, Drug encapsulation, Solar energy conversion in membrane mimetic system, Artificial photosynthesis.

### UNIT III

#### Bioanalytical techniques

Bioseparation processes- centrifugation, ultra centrifugation, adsorption, Extraction-liquid liquid extraction, solvent extraction, reverse micelle extraction, membrane separation processes BLM, SLM and ELM etc.

Affinity chromatography, gel filtration and size exclusion chromatography, Fluorescence spectroscopy.

### UNIT IV

#### Bio electrochemistry

Electrochemistry of membrane transport, ion selective electrodes, Types of ions selective electrodes - Glass membrane ISE, Solid membrane ISE, liquid membrane ISE, Enzyme based ISE.

Definition and classification of sensors, Glucose biosensor, Cholesterol biosensor, Biosensor to determine the freshness of fish, Biosensors based on Nicotinamide Adenine Dinucleotide cofactor, Ethanol biosensor based on a conducting polymer.

### UNIT V

#### Isotopes in biology

Radioactive decay, Interaction of Radioactivity with matter, measurement of radioactivity, liquid scintillation counting – use of stable isotopes in biology. Tracer techniques- use of isotopes as tracers in biological sciences, Some commonly used isotopes- safety aspects.

### Suggested Books

1. Chemistry – An introduction to general, organic and biological chemistry, VII Edn ,Karen C Timberlake, Benjamin/ Cummings, 1999.
2. Biological Chemistry by James P Allen, Wiley-Blackwell, 2008.
3. Biochemistry: Rawn, J. David, N. Patterson Publishers, 1989.
4. Introduction to Biophysical chemistry, R. Bruce Martin, McGraw-Hill, NY, 1964.
5. Physical Chemistry with applications to Biological systems, Ramond Chnag, Mc Millan publishing Co.inc, New York 1977.
6. Macromolecules: Structure and function, F. Wold, Prentice Hall, 1972.
7. Physicalbiochemistry; applications to biochemistry and molecular biology by Freifelder, David, San Francisco; WH Freeman and Company; 1976. 20
8. Environmental Biosensors, Edited by Vernon Somerset, ISBN 978-953-307-486-3, 356 pages, Publisher: InTech, Chapters, published under CC BY-NC-SA 3.0 license DOI:10.5772/929, 2011

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MCH-304E BIOINORGANIC CHEMISTRY  
Unit I

(5 credits)

## MCH-304E BIOINORGANIC CHEMISTRY

(5 credits)

### Unit I

#### Metal Ions in Biological Systems

General survey of essential and trace metals, Disturbing factors in metabolic process and causes of diseases, Recapitulation of Biological Roles of Metals & Ligands: Structural Information, Metal Activity, Specificity & Selectivity, Biochemical Evolution of Metals in Biological System

Alkali and alkaline earth metals in biological systems: Ionophores, active transport of cations across membranes, sodium pump, Calcium pump, Calcium carriers, role of carriers in muscle contraction, blood clotting and hormones.

### Unit II

Oxygen carriers: Porphyrins, metalloporphyrins, Hemoproteins, structure and functions of hemoglobin and myoglobin, synthetic oxygen carrier model systems, Storage & Transport Proteins of Iron viz., Ferritin & Transferrin, Siderophores

Cytochromes and their roles, Iron-Sulfur Proteins

### Unit III

Biochemistry of Cobalt: B12 Coenzymes and Model compounds, Adenosylcobalmin as a Coenzyme, Methylcobalmin as cofactor

Biological Chemistry of Copper: Type I, II & III, Blue Copper Proteins (Plastocyanins Azurins & Blue Oxidases), Non-blue copper proteins e.g. Tyrosinase, Galactose Oxidase, SOD etc.

Biological Chemistry of Zinc: Carboxypeptidase and Carbonic anhydrase enzymes

### Unit IV

Nitrogen fixation: *In vitro* and Biological nitrogen fixation, Nitrogenase, model for nitrogenase, metal-N<sub>2</sub> complexes

Photosynthesis, Role of chlorophyll, Photosystem I and photosystem II, Role of Mn

### Unit V

Bioinorganic Chemistry of Toxic Metals- Detoxification by Metal Chelation-Drugs which add by binding at the metal sites of Metalloenzymes- Radiation risks and medical benefits- Natural and man made Radio isotopes- Bioinorganic chemistry of Radio Pharmaceuticals, Platinum Complexes in Cancer Therapy- Cisplatin and its mode of action, Gold containing Drugs as Antirheumatic Agents and their mode of action, Lithium in Pschycopharmacological Drugs.

### Book Suggested

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, 1. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
3. Inorganic biochemistry vol. I and II ed. G.L. Eichhorn, Elsever.
4. Progress in Inorganic Chemistry, Vol 18 and 38 ed J.J. Lippard, Wiley.

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**Unit I****1. Conversion and Storage of Electrochemical Energy Present status of energy**

**consumption** : Pollution problem. History of fuel cells, Direct energy conversion by electrochemical means. Maximum intrinsic efficiency of an electrochemical converter. Physical interpretation of the Carnot efficiency factor in electrochemical energy converters. Power outputs.

electrochemical Generators (Fuel Cells) : Hydrogen oxygen cells, Hydrogen Air cell, Hydrocarbon air cell, Alkane fuel cell, Phosphoric and fuel cell, direct NaOH fuel cells, applications of fuel cells.

**Electrochemical Energy Storage :**

Properties of Electrochemical energy storage : Measure of battery performance, Charging and discharging of a battery, Storage Density, Energy Density. Classical Batteries : (i) Lead Acid (ii) Nickel-Cadmium, (iii) Zinc manganese dioxide. Modern Batteries : (i) Zinc-Air (ii) Nickel-Metal Hydride, (iii) Lithium Battery, Future Electricity storers : Storage in (i) Hydrogen, (ii) Alkali Metals, (iii) Non aqueous solutions.

**Unit II****Corrosion and Stability of Metals :**

Civilization and Surface mechanism of the corrosion of the metals; Thermodynamics and the stability of metals, Potential -pH (or Pourbaix) Diagrams; uses and abuses, Corrosion current and corrosion potential -Evans diagrams. Measurement of corrosion rate : (i) Weight Loss method, (ii) Electrochemical Method. **Inhibiting Corrosion** :

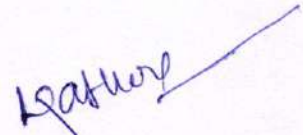
Cathodic and Anodic Protection. (i) Inhibition by addition of substrates to the electrolyte environment, (ii) by charging the corroding method from external source, anodic Protection, Organic inhibitors, The fuller Story Green inhibitors. **Passivation** : Structure of Passivation films, Mechanism of Passivation, Spontaneous Passivation Nature's method for stabilizing surfaces.

**Unit III****Bioelectrochemistry :**

bioelectrodics, Membrane Potentials, Simplistic theory, Modern theory, Electrical conductance in biological organism: Electronic, Protonic electrochemical mechanism of nervous systems, enzymes as electrodes.

**Kinetic of Electrode Process :**

Essentials of Electrode reaction. Current Density, Overpotential, Tafel Equation, Butler Volmer equation. Standard rate constant ( $K_0$ ) and Transfer coefficient ( $\alpha$ ), Exchange Current. **Irreversible Electrode processes** : Criteria of irreversibility, information from irreversible wave.





#### Unit IV

**Methods of determining kinetic parameters for quasireversible and irreversible waves :**  
Koutecky's methods, Meits Israel Method, Gellings method.

#### **Electrocatalysis :**

Chemical catalysts and Electrochemical catalysts with special reference to porostates, porphyrin oxides of rare earths. Electrocatalysis in simple redox reactions, in reaction involving adsorbed species. Influence of various parameters.

#### Unit V

#### **Potential Sweep Method :**

Linear sweep Voltammetry, Cyclic Voltammetry, theory and applications. Diagnostic criteria of cycli voltammetry. Controlled current microelectrode techniques : comparison with controlled potentials methods, chronopotentiometry, theory ad applications.

#### **Bulk Electrolysis Methods :**

Controlled potential coulometry, Controlled Coulometry, Electroorganic synthesis and its important applications. Stripping analysis : anodic and Cathodic modes, Pre electrolysis and Stripping steps, applications of Stripping Analysis.

#### Books Suggested

1. Modern Electrochemistry Vol. I, Ila, Vol. IIB J'OM Bockris and A.K.N. Reddy, Plenum Publication, New York.
2. Polarographic Techniques by L. Meites, Interscience.
3. "Fuel Cells : Thjeir electrochemistry". McGraw Hill Book Company, New York.
4. Modern Polarographic Methods by A.M. Bond, Marcell Dekker.
5. Polarography and allied techniques by K. Zutshi, New age International publicatin. New Delhi.
6. "Electroanalytical Chemistry by Basil H. Vessor & Galen W. ; Wiley Interscience.
7. Electroanalytical Chemistry by Basil H. Vessor & alen w. ; Wiley Interscience.
8. Topics in pure and Applied Chemistry, Ed. S. K. Rangrajan, SAEST Publication, Karaikudi (India)

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**Unit-I****Atmosphere**

Atmospheric layers, Vertical temperature profile, heat/radiation budget of the earth atmosphere systems. Properties of troposphere, thermodynamic derivation of lapse rate, Temperature inversion, Calculation of Global mean temperature of the atmosphere. Pressure variation in atmosphere and scale height. Biogeochemical cycles of carbon, nitrogen, sulphur, phosphorus oxygen, Residence times.

Sources of trace atmospheric constituents: nitrogen oxides, sulphur dioxide and other sulphur compounds, carbon oxides, chlorofluorocarbons and other halogen compounds, methane and other hydrocarbons.

Tropospheric Photochemistry: Mechanism of Photochemical decomposition of  $\text{NO}_2$  and formation of ozone. Formation of oxygen atoms, hydroxyl, hydroperoxy and organic radicals and hydrogen peroxide. Reactions of hydroxyl radicals with methane and other organic compounds. Reaction of OH radicals with  $\text{SO}_2$  and  $\text{NO}_2$ , Photochemical smog, meteorological conditions and chemistry of its formation.

**Unit-II****Air Pollution**

Air pollutants and their classifications. Aerosols-sources, size distribution and effect on visibility, climate and health, Acid rain precursors and their aqueous and gas phase atmospheric Oxidation reactions, Monitoring of  $\text{SO}_2$  and  $\text{NO}_x$ , Acid rain control strategies.

Stratospheric Ozone Depletion: Mechanism of Ozone formation, Mechanism of catalytic Ozone depletion, Discovery of Antarctic Ozone hole and Role of chemistry and meteorology. Control Strategies.

Green House Effect: Terrestrial and solar radiation Spectra, Major green house gases and their sources and Global warming potentials. Climate change and consequences.

Urban Air Pollution: Exhaust emissions, damaging effects of carbon monoxide. Monitoring of CO. Control strategies.

**Unit-III****Aquatic Chemistry and Soil Chemistry**

Redox chemistry in natural waters, Dissolved oxygen, biological oxygen demand, chemical oxygen demand, determination of DO, BOD and COD, Aerobic and anaerobic reactions of organic sulphure and nitrogen compounds in water acid-base chemistry of fresh water and sea water, Aluminum, nitrate and fluoride in water, Sources of water pollution, Treatment of waste and sewage, Purification of drinking water, techniques of purification and disinfection.

Physicochemical and bacteriological sampling as analysis of soil quality, Soil Pollution Control. Industrial waste effluents and heavy metals, their interactions with soil components, Soil micro – organisms and their functions, degradation of different insecticides, fungicides and weedicides in soil, Different kinds of synthetic fertilizers (N, P & K) and their interactions with different components of soil.



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## Unit IV

### Environmental Toxicology

**Toxic heavy metals** : Mercury, lead, arsenic and cadmium. Causes of toxicity. Bioaccumulation, sources of heavy metals. Chemical speciation of Hg, Pb, As, and Cd. Biochemical and damaging effects.

**Toxic Organic Compound** : Pesticides, classification, properties and uses of organochlorine and ionospheres pesticides detection and damaging effects.

**Polychlorinated biphenyls** : Properties, use and environmental continuation and effects.

**Polynuclear Aromatic Hydrocarbons** : Source, structures and as pollutants.

## Unit-V

### Green Chemistry

Principles and goals of green chemistry, Green chemicals, Green reagents, Green catalysts, Green solvents, Green organic synthesis in solid state, Emerging Green technologies like Microwave chemistry and sonochemistry, Photochemistry and electrochemistry, Green synthesis of Polycarbonates, Isocyanates and Urethanes, Green synthesis of Carbamyl pesticides.

### Books Suggested

1. Environmental Chemistry, Sharma & Kaur, Krishna Publishers.
2. Environmental Chemistry, A.K. De, Wiley Eastern
3. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern
4. Standard Method of Chemical Analysis, F.J. Welcher Vol. III, Van Nostrand Reinhold Co.
5. Environmental Toxicology, Ed. S. Landsberger and M. Creatchman, Gordon and Breach Science Publication.
6. Enviromental Chemistry, C. Baird, W.H. Freeman.
7. Environmental Chemistry, Colin Baird, W.H. Freeman Co. New York, 1998.
8. Chemistry of Atmospheres, R.P. Wayne, Oxford.
9. Environment Chemistry, A.K. De, Wiley Eastern, 2004.
10. Environmental Chemistry, S.E. Manahan, Lewis Publishers.
11. Introduction to atmospheric Chemistry, P.V. Hobbs, Cambridge.

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## Practical Syllabus

### SEMESTER III

(Duration: 6-8 hrs in each branch)

Practical examination shall be conducted separately for each branch.

#### Inorganic Chemistry

Quantitative determinations of a three component mixture	15
Chromatographic Separations	10
Record	04
Viva Voice	05

#### Quantitative determinations of a three component mixture :

Quantitative analysis of tri-component mixture of metal ions using gravimetric and volumetric techniques.

- Mixed solution of  $\text{Cu}^{2+}$ ,  $\text{Ni}^{2+}$  and  $\text{Zn}^{2+}$
- Mixed solution of  $\text{Cu}^{2+}$ ,  $\text{Ni}^{2+}$  and  $\text{Mg}^{2+}$
- Mixed solution of  $\text{Cu}^{2+}$ ,  $\text{Ag}^+$  and  $\text{Fe}^{2+}$
- Mixed solution of  $\text{Ni}^{2+}$ ,  $\text{Zn}^{2+}$  and  $\text{Fe}^{2+}$

#### Chromatographic Separations

Thin-layer chromatography-separation of nickel, manganese, cobalt and zinc. Determination of Rf values.

Separation of cations and anions by Paper Chromatography.

Cadmium and zinc

Zinc and magnesium.

### SEMESTER III

#### Organic Chemistry

Multi-step Synthesis of Organic Compounds	16
Paper Chromatography	08
Record	04
Viva Voice	05

#### Multi-step Synthesis of Organic Compounds

The exercise should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques.

- Beckmann rearrangement : Benzanilide from benzene Benzene  $\rightarrow$  Benzophenone  $\rightarrow$  Benzophenone oxime  $\rightarrow$  Benzanilide
- Benzilic acid rearrangement : Benzilic acid from benzoin Benzoin  $\rightarrow$  Benzil  $\rightarrow$  Benzilic acid
- Synthesis of heterocyclic compounds Skraup synthesis : Preparation of quinoline from aniline
- Fisher Indole synthesis : Preparation of 2-phenylindole from phenylhydrazine.

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## Thin layer and Paper Chromatography

Separation and identification of the sugars / amino acids present in the given mixture by TLC and Paper chromatography and determination of RF values

### SEMESTER III

#### Practical

(Duration: 6-8 hrs in each branch)

#### Physical Chemistry

Spectroscopy	12
Conductometry / Equilibrium and Dissociation Constants	12
Record	04
Viva Voice	05

#### Conductometry

1. Determination of solubility and solubility product of sparingly soluble salts (e.g.  $\text{PbSO}_4$ ,  $\text{BaSO}_4$ ) conductometrically.
2. Determination of the dissociation constant of acetic acid.
3. A commercial sample of vinegar is suspected of having  $\text{H}_2\text{SO}_4$ . Show conductometrically, if it is so and estimate the impurity of mineral acid if present.

#### Spectroscopy

1. Determination of  $\text{PK}_a$  of an indicator (e.g. methyl red) in (a) aqueous and (b) micellar media.
2. To verify Beers law for solution of  $\text{K}_2\text{Cr}_2\text{O}_7$  and  $\text{KMnO}_4$  using spectrophotometer and determine the concentrations in their solutions of unknown concentration.
3. To determine the composition of a binary mixture containing say  $\text{K}_2\text{Cr}_2\text{O}_7$  or  $\text{KMnO}_4$  spectrophotometrically.
4. Determination of stoichiometry and stability constant of Ferricisothiocyanation complex ion in solution.

#### Equilibrium and Dissociation Constants

1. To determine the equilibrium constant of the esterification reaction between acetic acid and ethanol.
2. To determine the equilibrium constant of the keto-enol tautomerism of ethylacetoacetate.
3. To determine the dissociation constant of picric acid by studying its distribution between benzene and water.

#### Books Suggested

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.
2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly. Prentice Hall.
3. Experiments and Techniques in Organic Chemistry, D.P. Pasto, C. Johnson and M. Miller, Prentice Hall.
4. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
5. Systematic Qualitative Organic Analysis, H. Middleton, Edward Arnold.
6. Handbook of Organic Analysis-qualitative and Quantitative. H. Clark, Edward Arnold.
7. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
8. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
9. Findley's Practical Physical chemistry, B.P. Levitt, Longman.
10. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.

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11. Inorganic Experiments, J. Derek Woolings, VCH.
12. Microscale Inorganic Chemistry, Z. Szafran, R.M. Pike and M.M. Singh, Wiley.
13. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Van Nostrand.
14. The systematic Identification of Organic Compounds, R.L. Shriner and D.Y. curlin.

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## SEMESTER IV

### Paper-I

#### MCH-401 APPLICATION OF SPECTROSCOPY II

(5 credits)

#### Unit-I

##### Ultraviolet and Visible spectroscopy

Various electronic transitions (185-800 nm) Beer-Lambert law, chromophores, auxochromes, intensity and wavelength shifts, types of bands, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds,  $\alpha$ ,  $\beta$ -unsaturated carbonyl compounds, dienes, conjugated polyenes, Fieser Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heteroaromatic compounds. Steric effect in biphenyls, olefins. Applications of UV-visible spectroscopy.

#### Unit-II

##### Infrared Spectroscopy

Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines, Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and fermi resonance.

#### Unit - III

##### Nuclear Magnetic Resonance of Paramagnetic Substances in Solution

The contact and Pseudo contact shifts, factors affecting nuclear relaxation, some applications including biochemical systems, an overview of NMR of metal nuclide with emphasis on  $^{195}\text{Pt}$  and  $^{119}\text{Sn}$  NMR.

#### Unit-IV

##### Two dimension NMR spectroscopy

Principle and pulse technique, DEPT with 3 different angles,  $^1\text{H}$ - $^1\text{H}$  COSY,  $^1\text{H}$ - $^{13}\text{C}$  COSY, NOESY, HMBC and HMQC techniques, interpretation of 2D spectra and examples

#### Unit-V

##### Mass Spectrometry

Introduction ion production E1, C1 FD, ESI and FAB, factors affecting fragmentation, ion analysis, ion abundance Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak. Me Lafferty rearrangement. Nitrogen rule. High resolution mass spectrometry. Structure elucidation of simple molecules using UV - Visible, IR, NMR and mass spectral techniques.

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Suggested Readings:

1. Physical Methods for Chemistry, R.S. Drago, Saunders Compnay.
2. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS.
3. Infrared and Raman Spectral : Inorganic and Coordination Compounds K. Nakamoto, Wiley.
4. Progress in Inorganic Chemistry vol., 8, ed., F.A. Cotton, vol., 15 ed. S.J. Lippard, Wiley.
5. Transition Metal Chemistry ed. R.L. Carlin vol. 3 dekker.
6. Inorganic Electronic Spectroscopy, A.P.B. Lever, Elsevier.
7. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, .V. Parish, Ellis Haywood.
8. Practical NMR Spectroscopy, M.L. Martin. J.J. Deepish and G.J. Martin, Heyden.
9. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler adn T.C. Morrill, John Wiley.
10. Introduction to NMR spectroscopy, R.J. Abraham, J. Fisher and P. Loftus, Wiley.
11. Application of Spectroscopy of Organic Compounds, J.R. Dyer Prentice Hall.
12. Spectroscopic Methods in Organic Chemistry D.H. Williams, I. Fleming, Tata McGraw-Hill.
13. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS.
14. Introduction to NMR spectroscopy, R.J. Abraham, J. Fisher and P. Loftus, Wiley.



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**Unit I****Introduction**

Classification of organometallic compounds by bond types viz. covalent, ionic, electron deficient and cluster compounds. Compound based on haptacity and polarity of M-C bond, Nomenclature and general characters, 18 Electron rule

Important reaction types: Oxidative addition and reduction, elimination, insertion (migratory) reactions,  $\beta$ -hydride elimination, nucleophilic attack

**Unit II****Alkyls and Aryls of Transition Metals**

Types, routes of synthesis, stability and decomposition pathways, organocopper compounds in organic synthesis.

**Compounds of Transition Metal-Carbon Multiple Bonds**

Transition metal-carbene complexes: Fischer type and Schrock type carbene complexes, their synthesis, reactions and structures & bonding; Transition metal-carbyne complexes: their synthesis, reactions and structural features

**Unit III****Transition Metal  $\pi$ -Complexes**

Transition metal  $\pi$ -complexes with unsaturated molecules, alkenes, alkynes, allyl, diene, dienyl(metallocene), arene, cyclooctatrienyl, cyclooctatetraene complexes, preparation, properties and nature of bonding and structural features, important reactions related to nucleophilic and electrophilic attack on ligands and to organic synthesis.

**Unit IV****Fluxional Organometallic Compounds**

Fluxionality & dynamic equilibria in compounds such as acyclic alkenes,  $\sigma$ -bonded and  $\pi$ -bonded cyclic alkenes, rotation of ligands on metals, ligand scrambling on metals.

**Unit V****Applications of Transition metal Organometallics as Catalysts**

Zeigler-Natta polymerization, homogeneous catalytic hydrogenation, alkene hydrogenation-Wilkinson Catalyst, Alkene Metathesis, Oxidation of olefins-Wacker's process, Carbonylation-Monsanto acetic acid Synthesis, hydroformylation of olefins – the oxo process.

**Book Suggested**

1. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
2. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree. John Wiley.
3. Metallo-organic Chemistry, A.J. Pearson, Wiley.
4. Organometallic Chemistry, R.C. Mehrotra and A. Singh New Age International.

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### Paper-III

#### MCH 403 ORGANIC SYNTHESIS

(5 credits)

##### Unit-I

###### Disconnection Approach

An introduction to synthons and synthetic equivalents. Disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reaction, amine synthesis. Protection of groups, chemo, region and stereo selectivity.

##### Unit-II

###### One Group C-C Disconnections

Alcohols, Alkyl halides, ethers and carbonyl compounds, regioselectivity, alkene synthesis, use of acetylenes and aliphatic Nitro compounds in organic synthesis.

###### Two Group C-C Disconnections

Regioselectivity and stereospecific of Diels-Alder Reaction, 1,3-difunctionalised compounds, a-b-unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalised compounds. Michael addition, Mannich and Robinson annelation.

##### Unit-III

###### Oxidation

Introduction, Different oxidative processes. Hydrocarbons-alkenes, aromatic rings, saturated C-H groups (activated and unactivated) Alcohols, diols, aldehyde's, ketones, ketals and carboxylic acids. Amines, hydrazines, and sulphides. Oxidations with ruthenium tetroxide, iodobenzene diacetate and thallium. (III) Nitrate.

###### Reduction

Introduction, Different reductive processes. Alkanes, alkenes, alkynes, and aromatic rings. Carbonyl compounds-aldehydes, ketones, acids and their derivatives. Epoxides. Nitro, nitroso, azo and oxime groups. Expoxide, Nitro, Nitroso, azo and oxime groups. Hydrogenolysis.

##### Unit-IV

###### Organometallic Reagents

Principle, preparations, properties and applications of the following in organic synthesis with mechanistic details. Group I and II metal organic compounds Li, Mg, Hg, Cd, Zn and Ce Compounds.

##### Unit-V

###### Synthesis of some complex molecules:

General methods of Structure elucidation and spectroscopic identification of terpenoids, alkaloids, flavonoids by taking the examples of Citral, Camphor, Progesterone, Androsterone, Papaverine, Tropic acid, Quercetin.

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Books Suggested:

1. Designing Organic Synthesis, S. Warren. Wiley.
2. Organic Synthesis-Concept, Methods and Starting Materials, J. Fuhrhop.
3. Some Modern Methods of Organic Synthesis. W. Carruthers, Cambridge Univ. Press.
4. Modern Synthetic Reactions H.O. House, W.A Benjamin.
5. Advanced Organic Chemistry : Reactions, Mechanisms and Structure, J. March. Wiley.
6. Principles, of Organic Chemistry Part B. F.a. Carey and R.J. Sundberg, Plenum Press.

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## ELECTIVE PAPERS

Out of the following select any two papers each of marks 50:

## ELECTIVE PAPERS

- OPT-1 MCH-404A Natural Product Chemistry
- OPT-2 MCH-404B Analytical Chemistry
- OPT-3 MCH-404C Medicinal Chemistry
- OPT-4 MCH-404D Material Chemistry
- OPT-5 MCH-404E Supramolecular and Nano Chemistry
- OPT-6 MCH-404F Chemistry of Textile Printing

## Interdisciplinary

- OPT-1 MCH-304G Instrumental Methods of Analysis

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**Unit I****Terpenoids and Carotenoids**

Calcifications, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules : Citral, Geraniol  $\alpha$ -Terpeneol, Menthol, Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and  $\beta$ -Carotene.

**Unit-II****Alkaloids**

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure, stereochemistry, synthesis and biosynthesis of the following : Ephedrine , (+)- Coniine, Nicotine, Atropine, Quinine and Morphine.

**Unit-III****Steroids**

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry, Isolation, Structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progesterone, Aldosterone, Biosynthesis of Steroids.

**Unit-IV****Plant Pigments**

Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Apigenin, Luteolin Quercetin, Myrcetin, Quercetin 3-glucoside, Vitexin, Diadzein, Aureusin, Cyanidin-7-arabinoside, Cyanidin, Hirsutidin, Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway.

**Prophyrins:** Structure and synthesis of Haemoglobin and Chlorophyll.

**Unit-V****Prostaglandin**

Occurrence, nomenclature, classification, biogenesis and physiological effects. Synthesis of PGE<sub>2</sub> and PGF<sub>2a</sub>.

**Pyrethroids and Rotenones**

Synthesis and reactions of Pyrethroids and Rotenones. (For structure elucidation, emphasis is to be placed on the use of spectral parameters wherever possible).

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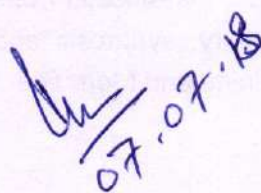
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**Books Suggested:**

1. Natural Products : Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.
2. Organic Chemistry : Vol. 2 1L. Finar, ELBS
3. Stereoselective Synthesis : A Practical Approach, M. Norgadi, VCH.
4. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
5. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M.P. Gupta and A. Marston. Harwood Academic Publishers.
6. Introduction to Flavonoids, B.A. Bohm. Harwood Academic Publishers.
7. New Trends in Natural Product chemistry, Ataur Rahman and M.L. Choudhary, Harwood Academic Publishers.
8. Insecticides of Natural Origin, Sukh Dev, Harwood Academic Publishers.

  
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## MCH-404B ANALYTICAL CHEMISTRY

(5 credits)

### Unit I

#### Introduction

Role of analytical chemistry, Classification of analytical methods classical and instrumental, Types of instrumental analysis. Selecting an analytical method, Neatness and cleanliness, laboratory operations and practices, Analytical balance, Techniques of weighing, errors, Volumetric glassware cleaning and calibration of glassware, Sample Volumetric glassware cleaning and Calibration of glassware, Sample preparation-dissolution and decompositions, Gravimetric techniques, Selecting and handling of reagents, Laboratory notebooks, Safety in the analytical laboratory.

**Errors and Evaluation** Definition of terms in mean and median, Precision-standard deviation, relative standard deviation, Accuracy-absolute error, relative error, Types of error in experimental data determinate (systematic), indeterminate (or random) and gross, Sources of error and the effects upon the analytical results, Methods for reporting analytical data, Statistical evaluation of data-indeterminate errors, The uses of statistics.

### Unit II

#### Food analysis

Moisture, ash, crude protein, fat crude fiber, carbohydrates, calcium, potassium, sodium and phosphate, Food adulteration-common adulterants in food, contamination of foods stuffs, Microscopic examination of foods for adulterants, Pesticide analysis in food products. Extraction and purification of sample, HPLC, Gas chromatography for organophosphates, Thin-layer chromatography for identification of chlorinated pesticides in food products.

### Unit III

#### Analysis of Water Pollution

Origin of Waste water, types, water pollutants and their effects, Sources of water pollution-domestic, industrial, agricultural soil and radioactive wastes as sources of pollution. Objectives of analysis-parameter for analysis-color, turbidity, total solids, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen, Heavy metal pollution-public health significance of cadmium, chromium, copper, lead, zinc, manganese, mercury and arsenic. General survey of instrumental technique for the analysis of heavy metals in aqueous systems, Measurements of DO, BOD, and COD, Pesticides as water pollutants and analysis, Water pollution laws and standards.

### Unit IV

#### Analysis of soil and Fuel, Body Fluids and Drugs

(a) Analysis of Soil, moisture pH total nitrogen, phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts.

(b) Fuel analysis: liquid and gas. Ultimate and proximate analysis-heating values-grading of coal, Liquid fuels-flash point, aniline point, octane number and carbon residue, Gaseous fuels-produced gas and water gas-calorific value

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## Unit V

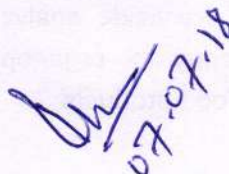
### Analysis of Body Fluids and Drugs

(a) **Clinical Chemistry** : Composition of blood-collection and preservation of samples. Clinical analysis. Serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumin, globulins, barbiturates, acid and alkaline phosphates. Immunoassay : principles of radio immunoassay (RIA) and applications. The blood gas analysis trace elements in the body

(b) **Drug analysis** : Narcotics and dangerous drug. Classification of drugs. Screening by gas and thin-layer chromatography and spectrophotometric measurements.

#### Books Suggested:

1. Analytical Chemistry, G.D. Christian, J.Wicy.
2. Fundamentals of analytical Chemistry. D.A. Skoog. D.M. West and F.J. Hooler, W.B. Saunders.
3. Analytical Chemistry-Principles. J.H. Kennedy. W.B. Saunders.
4. Analytical Chemistry-Principles and Techniques. LG. Hargis. Prentice Hall.
5. Principles of Instrumental analysis D.A. Skoog and J.L. Loary, W.B. Saunders.
6. Principles of Instrumental Analysis D.A. Skoog W.B. Saunders.
7. Quantitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
8. Environmental Solution, S.M. Khopkar, Wiley Eastern.
9. Basic Concepts of Analysis Chemistry, S.M. Khopkar, Wiley Eastern.
10. Handbook of Instrumental Techniques for Analytical Chemistry, F. Settle, Prentice Hall





**Unit I****Structure and activity**

Relationship between chemical structure and biological activity (SAR). Receptor Site Theory. Approaches to drug design. Concept of lead compound. Introduction to combinatorial synthesis in drug discovery. Factors affecting bioactivity. QSAR-Free-Wilson analysis, Hansch analysis, relationship between Free-Wilson analysis and Hansch analysis.

**Unit II****Pharmacodynamics**

Introduction, elementary treatment of enzymes stimulation, enzyme inhibition, sulfonamides, membrane active drugs, drug metabolism, xenobiotics, biotransformation, significance of drug metabolism in medicinal chemistry.

**Unit III****Antibiotics: Structure, Synthesis, SAR and mode of action of:**

Penicillins, Cephalosporins, Streptomycin, Chloramphenicol, Tetracyclines

**Unit IV****Antibacterials and antimalarials**

Synthesis and mode of action of Ciprofloxacin, Norfloxacin, Acyclovir.

Polyenes: Structure and synthesis of  $\beta$ - carotene, SAR and mode of action of polyenes with reference to amphotericin B.

**Antimalarials**

Chemotherapy of malaria. Synthesis, SAR and mode of action of: Chloroquine, Chloroguanide or proguanil and Mefloquine.

**Unit V****Non-steroidal Anti-inflammatory Drugs**

Classification with Structures, Synthesis, SAR and mode of action of Diclofenac Sodium, Ibuprofen and Nefopam

**Antihistaminic and antiasthmatic agents**

Classification with Structures, Synthesis, SAR and mode of action of Terfenadine, Cinnarizine, Salbutamol and Beclomethasone dipropionate.

**Books Suggested**

1. Introduction to medicinal chemistry, A. Gringuage, Wiley-VCH.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed Robert F Dorge.
3. An Introduction to Drug Design, S.S. Pandya and J.R. Dimmock, New Age Internaitonal.
4. Burger's Medicinal Chemistry and Drug Discovery, Vo-I (Chapter 9 and Chapter 14), Ed. M.E.Wolff, John Wiley.
5. Goodman and Gilman's Pharmacoloical Basis of Therapeutics, Mc GRaw-Hill.
6. The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman, Academic Press.
7. Strategies for Organic Drug synthesis and Design, D.Lednicer, John Wiley.
8. Principles of Medicinal Chemistry W.O.Foye
9. Medicinal Chemistry; The Role of organic chemist in Drug Research, S.M. Roberts and B.J. Pricer.

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## MCH-404D MATERIAL CHEMISTRY

(5 credits)

### Unit I

#### A. Multiphase materials

Ferrous alloys; Fe-C phase transformations in ferrous alloys; stainless steels, non ferrous alloys, properties of ferrous and non-ferrous alloys and their applications.

#### B. Glasses, Ceramics, Composites and Nanomaterials

Glassy state, glass formers and glass modifiers, applications. Ceramic structures, mechanical properties, clay products. Refractories, characterizations, properties and applications.

Microscopic composites; dispersion-strengthened and particle-reinforced, fibre-reinforced composites, macroscopic composites. Nanocrystalline phase, preparation procedures, special properties, applications.

### Unit II

#### A. Thin Films and Langmuir-Blodgett Films

Preparation techniques; evaporation/sputtering, chemical processes, MOCVD, sol-gel etc. Langmuir-Blodgett (LB) film, growth techniques, photolithography, properties and applications of thin and LB films.

#### B Liquid Crystals

Mesomorphic behaviour, thermotropic liquid crystals, positional order, bond orientational order, nematic and smectic mesophases; smectic-nematic transition and clearing temperature-homeotropic, planer and schlieren textures, twisted nematics, chiral nematics, molecular arrangement in smectic A and smectic C phases, optical properties of liquid crystals. Dielectric susceptibility and dielectric constants. Lyotropic phases and their description of ordering in liquid crystals.

### Unit III

#### A. Polymeric Materials

Molecular shape, structure and configuration, crystallinity, stress-strain behaviour, thermal behaviour, polymer types and their applications, conducting and ferro-electric polymers.

#### B. Ionic Conductors

Types of ionic conductors, mechanism of ionic conduction, interstitial jumps (Frenkel); vacancy mechanism, diffusion superionic conductors; phase transitions and mechanism of conduction in superionic conductors, examples and applications of ionic conductors.

### Unit IV

#### High $T_c$ Materials

Defect perovskites, high  $T_c$  superconductivity in cuprates, preparation and characterization of 1-2-3 and 2-1-4 materials, normal state properties; anisotropy; temperature dependence of electrical resistance; optical phonon modes, superconducting state; heat capacity; coherence length, elastic constants, position lifetimes, microwave absorption-pairing and multigap structure in high  $T_c$  materials, applications of high  $T_c$  materials.

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## Unit V

### A. Materials of Solid State Devices

Rectifiers, transistors, capacitors-IV-V compounds, low-dimensional quantum structures; optical properties.

### B. Organic Solids, Fullerenes, Molecular Devices

Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes-doped, fullerenes as superconductors

Molecular rectifiers and transistors, artificial photosynthetic devices, optical storage memory and switches-sensors.

Nonlinear optical materials; nonlinear optical effects, second and third order-molecular hyperpolarisability and second order electric susceptibility – materials for second and third harmonic generation.

### Book Suggested

1. Solid State Physics, N.W.Ashcroft and N.D.Mermin, Saunders College.
2. Materials Science and Engineering, An Introduction, W.D.Callister, Wiley.
3. Principles of the Solid State, H.V. Keer, Wiley Eastern.
4. Materials Sciences, J.C.Anderson, K.D.Leaver, J.M.Alexander and R.D. Rawlings, ELBS
5. Thermotropic liquid Crystals, Edl, G.W. Gray, John Wiley.
6. Handbook of Liquid Crystals, Kelker and Hatz, Chemie Verlag.



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## MCH-404E: SUPRAMOLECULAR AND NANO CHEMISTRY

(5 credits)

### Unit I

#### Concepts and Language

Properties of covalent bonds-bond length, inter-bond angles, force constant, bond and molecular dipole moments. Molecular and bond polarizability, bond dissociation enthalpy, entropy, intermolecular forces, hydrophobic effects. Electrostatic, induction, dispersion and resonance energy, magnetic interactions, magnitude of interaction energy, forces between macroscopic bodies, medium effects. Hydrogen bond.

### Unit II

#### Molecular recognition

molecular receptors, design and synthesis of receptors and coreceptor molecules. Multiple recognition, Molecular devices, Principle of molecular association and organizations, utilization of H bonds to create supramolecular structures and crystal engineering, Novel liquid crystals, Fullerenes, Dendrimers, Cation and anion binding hosts, binding of neutral molecules and organic molecules. Transport processes and carrier design, Ion Channels

### Unit III

#### Molecular devices and sensors

Principle and types- Electronic, Photonic and Ionic devices. Chemical sensors, Glass membrane sensors, Polymer membrane chemical sensors ( $\text{Ca}^{2+}$ ,  $\text{K}^+$ ,  $\text{F}^-$ ,  $\text{NO}_3^-$  Ion sensors) Biosensors, Glucose and cholesterol biosensor, Biosensor to determine the freshness of fish. Implantable electrodes.

### Unit IV

#### Nanotechnology

Concept and future prospects, elementary idea of miniaturized total analysis system ( $\mu\text{TAS}$ ) Preparation of nanomaterials and their characteristic differences over bulk material. Principle of electron microscopy, Dynamic light Scattering, Atomic force microscopy and characterization of nanomaterials.

### Unit V

#### Smart Materials and Nanomedicine

Calixarenes, Catenanes, Rotaxanes, Drug Encapsulation, functional drug carriers, Smart materials, smart instruments, surgical robots, Tissue Regeneration Scaffolds, Imaging devices

#### Books Suggested

1. Material Science and Engineering – An Introduction, William D. Callister, Jr., John Wiley & Sons
2. Materials Science & Engineering – A First Course, V. Raghavan, Prentice Hall
3. Nanostructured Materials and Nanotechnology, edited by Hari Singh Nalwa, Academic Press
4. Self Assembled Nanostructures, Jin Zhang, Zhong-lin Wang, Jun Liu, Shaowei Chen & Gang-Yu-Liu, Kluwer Academic/Plenum
5. Nanotechnology: A Gentle Introduction To The Next Big Idea, Ratner and Ratner
6. Membrane mimetic chemistry: characterizations and applications of micelles, microemulsions, monolayers, bilayers, vesicles, host-guest systems, and polyions, Fendler

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7. Advances in Nanoscience & Nanotechnology, Ashutosh Sharma, Jayesh Bellare, Archana Sharma
8. Principles of Nanotechnology: Molecular-Based Study of Condensed Matter in ... , G. Ali Mansoori
9. BioNanotechnology, Elisabeth S. Papazoglou, Aravind Parthasarathy



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**Textile Dyeing and Printing****UNIT I**

Introduction to Textiles, Textile fibers and their classification, essential and desirable properties of textile fibers, Characteristics of Fibre, Fiber Structure, physical and chemical properties of Man-made fibers, Formation and arrangement of Crystalline and Amorphous region in fiber and their influence on various properties of fibres. Study of new fibers- Lycra, lyocel, ultra fine fibers, , photo adoptive fibers, intelligent fibers, nano fibers and medical fibers. Manufacturing processes - Bonded fabrics , felt fabrics, laminated fabrics.

**UNIT II**

Nomenclature of Dyes, Colour and Dyes, colouring and Dyeing. Chromophores and Auxochromes. Colour theory, introduction about chemical constitution, properties, methods of application and suitability of various dyes to different fibers and their blends.

Theory of dyeing -Affinity of a dye, role of water, electrolytes, heat. Dye auxiliary - Carriers or swelling agents, leveling agents, anionic and cationic leveling agents. Classification of dye-stuff and its properties- (a) Natural dyes- Vegetable and Mineral dyes (b) Synthetic dyes - Acid dyes, direct dyes, reactive dyes, Vat dyes, Sulphur dyes, Azoic dyes.

**UNIT III**

Textile Testing and Quality Control - Selection of textile material for research based on textile testing methods. Random Sampling procedure for determination of properties of fibers, yarn and fabric. Measurement of air permeability of fabrics, fabric drape. Drape meter crease resistance and crease recovery, abrasion testing of abrasion resistance. Different Color fastness tests. Fabric Testing: Pilling of fabric, pilling tester assessment of pilling. Flammability some definitions and terms used relating to flammability, flame proof material, factors affecting flame resistance.

**UNIT IV**

New developments in textiles- Industrial textiles- Geo textiles ,medical, nano textiles, smart textiles, Protective Clothing ,Automotive Textile. Fundamentals of Computer and application of C A T D (Computer Aided Textile Designing )

Chemical treatment of cloth before printing, General principle of printing, Methods of printing, block printing, digital printing, discharge printing, pigment printing, resist printing, Styles of printing and their fixation methods.

**UNIT V**

Small scale industry: Definition; Characteristics; Need and rationale: Objectives: Scope; role of SSI in Economic Development. Advantages of SSI, Steps to start in SSI, Impact of Liberalization, Privatization, Globalization on S.S.I. , How to start a small scale industry, Procedures for registration of small scale industry , List of items reserved for exclusive manufacture in small scale industry, Assessment of demand and supply in potential areas of growth , Understanding business opportunity , Considerations in product selection, Data collection for setting up small ventures. Environmental aspects of fabrics, dyes, chemicals and packaging, Indian and International textiles, Eco Labels, standards, quality control, strategy, information systems, Eco or green design, ,Concept of recycling materials and their visual aspects.

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### Suggested Books

1. J. E. Booth- Principle of Textile Testing – Meanness Butterbroths, London.
2. Growerand Hamley – Handbook of Textile Testing and quality control,
3. wilegJohn H. Skihle – Textile Testing – Chemical Publishing Co. Inc. Brooklyn,
4. Gerry Cookline, Garments-Technology for Fashion Designers, Man Milan Co.
5. Fiber to fabric, Begnard P. Corbman, McGrawHillInternatinaleditins.
6. K.I. Floyd and H.M. Taylor- Industrial Application of Textiles, Textile Institute, Manchester.
7. R.Marks and A. T. C. Robinson -Principles of weaving-
8. D.B. Ajronkar- Knitting technology
9. Shenai V. A. -History of Textile Design, Principles and practice of dyeing.
10. Watson- Textile design and colour, universal publishing corporation.

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**Unit I****Spectrochemical Methods**

**Spectrophotometry:** Principles of absorption, instrumentation, single beam, double beam, determination of pKa value of an indicator, detectors, applications

**Atomic Absorption Spectroscopy:** Principles, Instrumentation, monochromator, detector, Sensitivity and detection limits, Interferences in AAS and their elimination.

**Atomic Emission Spectroscopy:** Principles, Sources for excitation, Instrumentation, Qualitative and quantitative Analysis.

**Flame Photometry:** Principles, Interferences, Evaluation methods in Flame Photometry

**Unit II****Electroanalytical Methods and Thermal methods**

General principles of polarography, derivation of Ilkovic equation, consequences of the Ilkovic equation, half-wave potential, equations for reversible cathodic, anodic, and cathodic-anodic waves, analysis of reversible polarographic wave, factors affecting the half-wave potential, Cyclic voltammetry, Linear-scan voltammetry, Pulse voltammetric methods, Voltammetry with ultra micro electrodes, stripping methods, Amperometry, Amperostatic Coulometry, Coulometric titrations and controlled-potential electrolysis.

Principles and instrumentation of TG and DTA, Complementary nature of TG and DTA, Differential scanning calorimeter (DSC), Applications of thermal methods in analytical chemistry

**Unit III****Separation Techniques**

Principles of analytical separations, liquid-liquid extraction : Distribution coefficient, distribution ratio, solvent extraction of metals, multiple batch extractions, countercurrent distribution., multiple extractions, Accelerated and microwave assisted extraction, Solid Phase extraction. Principles of Chromatographic separations, Theory of column efficiency in chromatography, Retention time ( $R_t$ ) and Retardation factor ( $R_f$ ), Resolution.

**Unit IV****Chromatography**

Classification of chromatographic separations, Techniques and applications of chromatographic methods: Adsorption and partition chromatography, paper chromatography, Thin-Layer Chromatography, Column Chromatography, High Pressure Liquid Chromatography (HPLC), Gas Chromatography, Ion-Exchange Chromatography, Size Exclusion, Affinity and chiral columns, Counter-Current distribution and Electrophoresis and other hyphenated Techniques like LC-MS, GC-MS, IC-MS, HP-TLC, and ICP-MS Spectroscopy

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## Unit V

### Electron Microscopy

Theory and applications of Scanning Probe microscopy: Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM).

Characterization of nanomaterials by XRD, SEM, Energy dispersive X-ray Analysis, TEM, AFM techniques. Nanoscale Lithography and its types, Nano sensors and their types, zeta sizer

### Suggested Reading

1. D. A. Skoog, D. M. West and F.J.Holler, Fundamentals of Analytical Chemistry, 2<sup>nd</sup> Ed., Saunders College Publishing, 1991.
2. R.A.Day and A.L.Underwood, Quantitative Analysis, 6<sup>th</sup> Ed., Prentice-Hall of India Pvt.Ltd., 1993.
3. Gas Chromatography, Open Book Learning Series
4. Larry Hargis, Analytical Chemistry. Principles and techniques
5. Analytical Chemistry - G. D. Christian.
6. Analytical Chemistry - Principles – J. K. Kennedy and W. B. Saunders.
7. Instrumental Methods of Chemical Analysis – B. K. Sharma.
8. Spectrometric identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.
9. Introduction to NMR Spectroscopy, R. J. Abraham, J. Fisher and P. Loftus, Wiley.
10. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
11. Spectroscopy Methods in Organic Chemistry, D. H. Williams, I. Fleming, Tata McGraw-Hill.
12. Spectroscopy of Organic Compounds, P. S. Kalsi, New Age International Ltd.
13. Modern Spectroscopy, J.M.Hollas, John Wiley
14. Physical Methods in Chemistry, R.S.Drego, Saunders Collge
15. Introduction to Molecular Spectroscopy, G.M.Barrow, McGraw Hill

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## Practical Syllabus

### SEMESTER IV

(Duration: 6-8 hrs in each branch)

Practical examination shall be conducted separately for each branch.

#### Inorganic Chemistry

Preparation	12	
Instrumentation		12
Record	04	
Viva Voice	05	

#### Preparation

Preparation of selected inorganic compounds and their study by IR, electronic spectra, and magnetic susceptibility measurements. Handling of air and moisture sensitive compounds involving vacuum lines.

Selection can be made from the following :

1. Sodium tetrathionate  $\text{Na}_2\text{S}_4\text{O}_6$ .
2. cis-[Co(trien)  $(\text{NO}_2)_2$ ]Cl.H<sub>2</sub>O
3. Metal complex of dimethyl sulfoxide :  $\text{CuCl}_2 \cdot 2\text{DMSO}$  J.Chem. Educ., 1982, 59, 57.
4. Synthesis of metal acetylacetonate : Inorg. Synths, 1957, 5, 130, 1963, 1, 183.
5. tris(acetylacetonato)manganese(III),  $[\text{Mn}(\text{acac})_3]$ ;
6. Bis(acetylacetonato) complexes of Cu(II), Co(II), and Ni(II)
7. Cis and Trans  $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ .
8.  $\text{Cu}_2\text{Hgl}_4$

#### Spectrophotometric Determinations

- a. Nickel by extractive spectrophotometric method.
- b. Copper-Ethylene diamine complex : Slope-ratio method.
- d. Determination of  $K_{eq}$  of M – L systems such as Fe (III) – Salicylic acid or Fe(III) –  $\beta$  – resorcinic acid by Job's & Mole ratio method.

#### Flame Photometric Determinations

- a. Sodium and potassium when present together.
- b. Lithium/calcium/barium/strontium.
- c. Cadmium and magnesium in tap water.

#### Potentiometric Titrations:

1. FAS Vs  $\text{K}_2\text{Cr}_2\text{O}_7$
2. FAS Vs.  $\text{KMnO}_4$
3. Determination of phosphoric acid in cola beverages by pH titration.

#### Conductometry.

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1. Verification of Debye Huckle theory of ionic conductance for strong electrolytes KCl, BaCl<sub>2</sub>, K<sub>2</sub>SO<sub>4</sub>, K<sub>3</sub>[Fe(CN)<sub>6</sub>]
2. Conductometric Titrations: (a) NaOH Vs. HCl (b) NaOH Vs. Boric acid

Analysis of Electronic Spectra of transition metal complexes at least for one system [dn (Oh) or (Td)] and calculation of Crystal Field parameters, interelectronic repulsion parameter and bonding parameter.

#### SEMESTER IV

##### Organic Chemistry

Extraction of Organic Compounds from Natural Sources 12

Spectrophotometric Determinations or Estimations 12

Record 04

Viva Voice 05

##### Extraction of Organic Compounds from Natural Sources

1. Isolation of caffeine from tea leaves.
2. Isolation of casein from milk
3. Isolation of lactose from milk
4. Isolation of nicotine dipicrate from tobacco.
5. Isolation of piperine from black pepper.
6. Isolation of lycopene from tomatoes.
7. Isolation of b-carotene from carrots.
8. Isolation of (+) limonine from citrus rind.

##### Spectroscopy

Identification of organic compounds by the analysis of their spectral data (UV, IR, PMR, CMR & MS)

##### Spectrophotometric (UV/VIS) Estimations

1. Amino acids
2. Proteins
3. Carbohydrates

Or

Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method.

Estimation of amines/phenols using bromate bromide solution/or acetylation method.

Estimation of glucose by Fehling solution

## SEMESTER IV

### Physical Chemistry

Thermodynamics/Instrumentation	12
Chemical Kinetics	12
Record	04
Viva Voice	05

### Thermodynamics

1. Determination of partial molar volume of solute (e.g. KCl) in a binary mixture.
2. Determination of partial molar volume of ethanol in a binary mixture.
3. Determination of the temperature dependence of the solubility of a compound in two solvents having similar intramolecular interactions (benzoic acid in water and in DMSO water mixture and calculate the partial molar heat of solution).

### Chemical Kinetics

1. Determination of energy and enthalpy of activation in the reaction of  $\text{KMnO}_4$  and benzyl alcohol in acid medium.
2. Determination of the velocity constant for the oxidation of iodide ions by hydrogen peroxide study the kinetics as an iodine clock reactions.
3. Kinetics of an enzyme catalyzed reaction.

### Potentiometry

15. Estimation of halides ( $\text{Cl}^-$ ,  $\text{Br}^-$  and  $\text{I}^-$ ) in a binary and ternary mixture potentiometrically.
16. To find out the composition of zinc ferrocyanide precipitate on adding zinc sulphate to acidified potassium ferrocyanide solution potentiometrically.

### Books Suggested

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham, ELBS.
2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall.
3. Experiments and Techniques in Organic Chemistry, D.P. Pasto, C. Johnson and M. Miller, Prentice Hall.
4. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
5. Systematic Qualitative Organic Analysis, H. Middleton, Edward Arnold.
6. Handbook of Organic Analysis-qualitative and Quantitative. H. Clark, Edward Arnold.
7. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
8. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
9. Findley's Practical Physical chemistry, B.P. Levitt, Longman.
10. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.
11. Inorganic Experiments, J. Derek Woolings, VCH.
12. Microscale Inorganic Chemistry, Z. Szafran, R.M. Pike and M.M. Singh, Wiley.
13. Practical Inorganic Chemistry, G. Marr and B. W. Rockett, Van Nostrand.
14. The systematic Identification of Organic Compounds, R.L. Shriner and D.Y. Curtin.

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