CHOICE BASED CREDIT SYSTEM

Syllabus of M.Sc. in Chemistry

[Effective from the Academic Session 2019-2020]

JIS UNIVERSITY,
81, Nilgunj Road, Agarpara
Kolkata -700109

CREDIT DISTRIBUTION ACROSS THE COURSE				
Course Type	**Total Papers**	**Credit**		**Credit**
		Theory	**Practical**	
CORE COURSES (CC)	15	8 × 4 = 32	6 × 2 = 12 1 × 6 = 6	32 + 18 = 50
SPECIAL PAPERS	4	3 × 4 = 12	1 × 4 = 4	12 + 4 = 16
ELECTIVE PAPERS	3	3 × 2 = 6	0	6
CBCS	2	8	0	8
			Total Credit	**80**
NON-CGPA				
AECC	8	1 × 8 = 8		8
			Grand Total Credit	**88**

Abbreviations Used:

CC = CORE COURSES
CBCS = GENERAL ELECTIVES
AECC = ABILITY ENHANCEMENT COMPULSORY COURSES
NON-CGPA = NON CREDIT COURSES

CREDIT AND MARKS DISTRIBUTION ACROSS THE COURSE		
SEMESTER	**CGPA CREDIT**	**MARKS**
I	22	550
II	22	550
III	18	450
IV	18	450
TOTAL	**80**	**2000**
SEMESTER	**NON CGPA CREDIT**	**MARKS**
I	2	50
II	2	50
III	2	50
IV	2	50
TOTAL	**8**	**200**

SEMESTER WISE CREDIT/MARKS DISTRIBUTION SEMESTER I								
COURSE TYPE	**SUBJECT CODE**	**SUBJECT NAME**	**L**	**T**	**P**	**CREDIT**	**CONTACT HOURS**	**MARKS DISTRIBUTION**
CC 1	MCH-101	INORGANIC CHEMISTRY-I	**3**	**1**	**0**	4	4	100
CC 2	MCH-102	ORGANIC CHEMISTRY-I	**3**	**1**	**0**	4	4	100
CC 3	MCH-103	PHYSICAL CHEMISTRY-I	**3**	**1**	**0**	4	4	100
CC 4	MCH-191	INORGANIC CHEMISTRY LAB-I	**0**	**0**	**2**	2	4	50
CC 5	MCH-192	ORGANIC CHEMISTRY LAB-I	**0**	**0**	**2**	2	4	50
CC 6	MCH-193	PHYSICAL CHEMISTRY LAB-I	**0**	**0**	**2**	2	4	50
CBCS 1	****	****	**3**	**1**	**0**	4	4	100
		TOTAL	**12**	**4**	**6**	**22**	**28**	**550**
NON-CGPA								
AECC-1	MSD-181	SEMINAR & OTHER ACTIVITIES	**0**	**0**	**1**	1	1	**25**
AECC-2	MSD-182	SKILLX & NSS	**0**	**0**	**1**	1	1	**25**
		TOTAL	**12**	**4**	**8**	**24**	**30**	**600**

SEMESTER WISE CREDIT/MARKS DISTRIBUTION SEMESTER II								
COURSE TYPE	**SUBJECT CODE**	**SUBJECT NAME**	**L**	**T**	**P**	**CREDIT**	**CONTACT HOURS**	**MARKS DISTRIBUTION**
CC 7	MCH-201	INORGANIC CHEMISTRY-II	**3**	**1**	**0**	4	4	100
CC 8	MCH-202	ORGANIC CHEMISTRY-II	**3**	**1**	**0**	4	4	100
CC 9	MCH-203	PHYSICAL CHEMISTRY-II	**3**	**1**	**0**	4	4	100
CC 10	MCH-291	INORGANIC CHEMISTRY LAB-II	**0**	**0**	**2**	2	4	50
CC 11	MCH-292	ORGANIC CHEMISTRY LAB-II	**0**	**0**	**2**	2	4	50
CC 12	MCH-293	PHYSICAL CHEMISTRY LAB-II	**0**	**0**	**2**	2	4	50
CBCS 2	****	****	**3**	**1**	**0**	4	4	100
		TOTAL	**12**	**4**	**6**	**22**	**28**	**550**
NON-CGPA								
AECC-3	MSD-281	SEMINAR & OTHER ACTIVITIES	**0**	**0**	**1**	1	1	**25**
AECC-4	MSD-282	SKILLX & NSS	**0**	**0**	**1**	1	1	**25**
		TOTAL	**12**	**4**	**8**	**24**	**30**	**600**

SEMESTER WISE CREDIT/MARKS DISTRIBUTION SEMESTER III								
COURSE TYPE	**SUBJECT CODE**	**SUBJECT NAME**	**L**	**T**	**P**	**CREDIT**	**CONTACT HOURS**	**MARKS DISTRIBUTION**
CC 13	MCH-301	PRINCIPLES AND APPLICATIONS OF MOLECULAR SPECTROSCOPY	**3**	**1**	**0**	4	4	100
SPECIAL 1	MCH-302/303/304	SPECIAL PAPER I: INORGANIC/ORGANIC/PHYSICAL	**3**	**1**	**0**	4	4	100
SPECIAL 2	MCH-305/306/307	SPECIAL PAPER II: INORGANIC/ORGANIC/PHYSICAL	**3**	**1**	**0**	4	4	100
ELECTIVE 1	****	*****	**2**	**0**	**0**	2	2	50
SPECIAL 3	MCH-391/392/393	SPECIAL PAPER III: INORGANIC SPECIAL PRACTICAL/ORGANIC SPECIAL PRACTICAL /PHYSICAL SPECIAL PRACTICAL	**0**	**0**	**4**	4	12	100
		TOTAL	**11**	**3**	**4**	**18**	**26**	**450**
NON-CGPA								
AECC-5	MSD-381	SEMINAR & OTHER ACTIVITIES	**0**	**0**	**1**	1	1	**25**
AECC-6	MSD-382	SKILLX & NSS	**0**	**0**	**1**	1	1	**25**
		TOTAL	**11**	**3**	**6**	**20**	**28**	**500**

SEMESTER WISE CREDIT/MARKS DISTRIBUTION SEMESTER IV								
COURSE TYPE	**SUBJECT CODE**	**SUBJECT NAME**	**L**	**T**	**P**	**CREDIT**	**CONTACT HOURS**	**MARKS DISTRIBUTION**
CC 14	MCH-401	SPECTROSCOPY FOR STRUCTURE ELUCIDATION	**3**	**1**	**0**	4	4	100
SPECIAL 4	MCH-402/403/404	SPECIAL PAPER IV: INORGANIC/ORGANIC/PHYSICAL	**3**	**1**	**0**	4	4	100
ELECTIVE 2	****	****	**2**	**0**	**0**	2	2	50
ELECTIVE 3	****	*****	**2**	**0**	**0**	2	2	50
CC 15	MCH-491	DISSERTATION	**0**	**0**	**6**	6	12	150
		TOTAL	**10**	**2**	**6**	**18**	**24**	**450**
NON-CGPA								
AECC-7	MSD-481	SEMINAR & OTHER ACTIVITIES	**0**	**0**	**1**	1	1	**25**
AECC-8	MSD-482	SKILLX & NSS	**0**	**0**	**1**	1	1	**25**
		TOTAL	**10**	**2**	**8**	**20**	**26**	**500**

SEMESTER III

- **SPECIALIZATION PAPER I**

MCH-302: Advanced Bioinorganic and Organometallics
MCH-303: Advanced Organic Synthesis I
MCH-304: Advanced Quantum Mechanics

- **SPECIALIZATION PAPER II**

MCH-305: Advanced Topics in Inorganic Chemistry I
MCH-306: Biochemistry, Pericyclic and Photochemistry
MCH-307: Solid State Chemistry

- **SPECIALIZATION PAPER III**

MCH-391: Inorganic Special Practical
MCH-392: Organic Special Practical
MCH-393: Physical Special Practical

- **ELECTIVE PAPER I**

MCH-308: Supramolecular Chemistry and Drug Design
MCH-309: Nuclear Chemistry

SEMESTER IV

- **SPECIALIZATION PAPER IV**

MCH-402: Advanced Topics in Inorganic Chemistry II
MCH-403: Advanced Organic Synthesis II
MCH-404: Electrochemistry and Statistical Mechanics

- **ELECTIVE PAPER II**

MCH-405: Polymer Chemistry
MCH-406: Advanced Spectroscopy

- **ELECTIVE PAPER III**

MCH-407: Materials Chemistry
MCH-408: Industrial Chemistry

Detailed Syllabus of First semester

MCH-101: INORGANIC CHEMISTRY-I

L-T-P: 3-1-0 **Credit: 4**

Unit 1: Coordination Chemistry

Crystal field theory, Splitting of d orbitals in linear, triangular, tetrahedral, square planar, trigonal bipyramidal, square pyramidal, octahedral and pentagonal bipyramidal fields of similar and dissimilar ligands. Kinetic aspects of crystal field stabilization, crystal field activation energy, labile and inert complexes. Limitations of CFT, evidences of metal-ligand orbital overlap, nephelauxetic series; spectrochemical series. Magnetic properties – elementary idea.

Unit 2: Electronic Spectra of Transition Metal Complexes:

Electronic spectra of transition metal complexes – determination of free ion terms, microstates, determination of ground and all excited state terms of d^n terms in octahedral and tetrahedral fields, Orgel diagrams (qualitative approach), hole formalism, inversion and equivalence relations, selection rules for spectral transitions, d-d spectra and crystal field parameters, Nephelauxeti series, qualitative idea of Tanabe–Sugano diagrams, charge transfer spectra.

Unit 3: Chemistry of f-Block Elements

Lanthanide and actinide elements: terrestrial abundance and distribution, relativistic effect, variation of atomic and ionic radius, ionization energy, electronic configuration and oxidation states, magnetic properties, electronic spectra, aqueous and complex chemistry in different oxidation states, use of lanthanide compounds as NMR-shift reagent.

Unit-4: Environmental Chemistry

Air pollution: major air pollutant, Greenhouse effect, mechanistic pathways of smog formation and ozone hole, acid rain, global warming, technology of air pollution abatement.

Water pollution: classification of water pollutants, characteristics of waste water, water quality parameters and their measurements, biochemical effects of As, Pb, Cd, Hg and their chemical speciation, eutrophication, waste water treatment: preliminary, primary, secondary, and tertiary treatment.

Soil pollution: chemical composition of the soil, the exploitation of the mineral resources and abuse of the earth, soil pollution due to natural and artificial agencies and its effects, remedial measures to check the pollution.

Recommended Books

1. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn. (1999), John Wiley & Sons, New York.
2. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry, Principles of structure and reactivity, Harper Collins 1993.
3. R. S. Drago, Physical Methods in Inorganic Chemistry, International Edn. (1971), Affiliated East-West Press, New Delhi.
4. Keith F. Purcell and John C. Kotz, Inorganic Chemistry, W. B. Sauders Com. (1987), Hong Kong.
5. B.N. Figgis, Introduction to Ligand Fields, Wiley Eastern Ltd. New Delhi (1976).
6. D. J. Newman, Betty, Crystal Field, Science, 2000
7. M. Chanda, Structure and Chemical bond, Tata McGraw Hill Atomic Edition, 2000.
8. D. F. Shriver, P. W. Atkins and C. H. Langford, Inorganic Chemistry, Oxford University Press, 1990.
9. R. L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, Modern Methods of Chemical Analysis, 2nd Edition (1976), John Wiley, New York.
10. G. D. Christian, Analytical Chemistry, 5th Edition (1994), John Wiley & Sons, New York.
11. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry - An Introduction, 7th Edition (2000), Saunders College Publishing, Philadelphia, London.
12. J. H. Kennedy, Analytical Chemistry: Principles, 2nd Edition (1990), Saunders Holt, London.
13. Mani Vasakam, Physico Chemical Examination of Water, Sewage and Industrial effluents, Pragati Prakashan, 1991
14. F. W. Fifield and W. P. J. Hairens, Environmental Analytical Chemistry, 2nd Edition (2000), Black Well Science Ltd.
15. Colin Baird, Environmental Chemistry, W. H. Freeman and Company, New York (1995).
16. A. K. De, Environmental Chemistry, 4th Edition (2000), New Age International Private Ltd., New Delhi.
17. Peter O. Warner, Analysis of Air Pollutants, 1st Edition (1996), John Wiley, New York.
18. S. M. Khopkar, Environmental Pollution Analysis, 1st Edition (1993), Wiley Eastern Ltd., New Delhi.
19. S. K. Banerji, Environmental Chemistry, 1st Edition (1993), Prentice-Hall of India, New Delhi.

MCH-102: ORGANIC CHEMISTRY I

L-T-P: 3-1-0 **Credit: 4**

Unit 1: Aromaticity

Huckel's rule, concept of aromaticity in benzenoid and nonbenzenoid systems, alternate and non-alternante hydrocarbons, annulenes, heteroannulenes, fullerenes, anti-aromaticity, pseudo-aromaticity, homo-aromaticity.

Unit 2: Stereochemistry

Different projection formulae and their interconversions. Conformational and configurational enantiomers. Stereochemical nomenclatures: (E, Z), chiral centre, chiral axis, chiral plane, helicity, threo-erythro, pref-parf, chiral simplex. Stereogencity and chirotopicity. Symmetry and molecular chirality. point group, *conformation:* conformational analysis of acyclic, cyclic, fused, spiro and bridged bicyclo-systems with typical examples. Computation of stereoisomers of different systems. Conformation and relative reactivity of diastereomers. 2-, 3-, and 4- Alkyl ketone effects. Stereoisomerism, configuration: relative and absolute, determination of relative configuration: Prelog's rule, Cram's rule, Felkin and Karabatsos and Sharpless rule.

Unit 3: Reaction Mechanism

Concise review on nucleophilic, electrophilic substitution reactions, and elimination reactions, neighbouring group participation: the phenonium ion, participation by π and σ bonds, Anchimeric assistance, classical versus non-classical carbonium ions- the present status.

Addition to carbon-carbon multiple bonds: mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemo-selectivity, orientation and reactivity, hydrogenation, hydroboration reaction.

Addition to carbon-hetero multiple bonds: mechanism of metal hydride reaction of substituted and unsubstituted carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organocopper, organozinc, organolithium and organosilane reagents to saturated and unsaturated carbonyl compounds.

Recommended Books

1. Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2001.
2. M.B. Smith & Jerry March, March's Advanced Organic Chemistry, 5th Edition (2001), John Wiley & Sons, New York.
3. Peter Sykes, A Guide book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman Ltd., New Delhi.
4. S. M. Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, Ist Edition (1990), Macmillan India Ltd., New Delhi.
5. D. Nasipuri, Stereochemistry of Organic Compounds, 2nd Edition (1994), Wiley Eastern Ltd., New Delhi.
6. E.L. Eliel, S.H. Wilen and L.N. Mander, Stereochemistry of Organic Compounds, Wiley Interscience, New York (2004).

MCH-103: PHYSICAL CHEMISTRY I

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Thermodynamics

Concise review of thermodynamics, concept of partial molar quantities and their significances, Nernst heat theorem, consequences of Nernst heat theorem, entropy and third law of thermodynamics: determination of absolute entropy, concept and significance of residual entropy.

Thermodynamic probability and entropy, distribution laws: Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac, concept of partition function: rotational, translational, vibrational and electronic partition functions of diatomic molecules, concept of ensembles, relation between partition functions with various thermodynamic functions, Gibb's paradox.

Unit-2: Chemical Kinetics

Concise review of chemical kinetics, fast reactions: luminescence and energy transfer processes, kinetics study of fast reactions by stopped–flow and relaxation, and flash photolysis methods.

Rate equations of photochemical, chain and oscillatory reactions, thermodynamic treatment of transition state theory, theories of unimolecular reactions: Lindemann-Christiansen hypothesis, Hinshelwood, Rice-Ramsperger- Kassel (RRK), and Rice- Ramsperger-Kassel-Marcus (RRKM).

Unit-3: Surface Chemistry

Adsorption: different types of adsorption, absorption vs adsorption, different adsorption isotherms, unimolecular and bimolecular surface reaction, activation energy of such reactions, volcano curve.

Transition state theory of surface reactions: rates of chemisorptions and desorption, unimolecular and bimolecular surface reaction.

Micelles: Surface active agents and their classifications, micellization, factors affecting cmc of surfactants. Thermodynamics of micellization: phase separation and mass action models. Emulsions and reverse micelle.

Recommended Books

1. G.W. Castellan, Physical Chemistry, 3rd Edition, Narosa Publishing House
2. P.W. Atkins, Physical Chemistry, 8th Editions, Oxford University Press, New York
3. K.J. Lailder, Chemical Kinetics, 3rd Edition, Pearson
4. I.N. Levine, Physical Chemistry, 5th Edition, Tata McGraw Hill Publication Co, Ltd, New Delhi
5. B.K. Agarwal and M. Eisner, Statistical Mechanics, Wiley Eastern, New Delhi
6. D.A. Mcquarrie, Statistical Mechanics, California University Science Books
7. R. K. Patharia, Statistical Mechanics, Butterworth, Heinemann, Elsevier
8. Y. Moroi, Micelles: Theoretical and Applied Aspects, Plenum Press, New York (1992)
9. T. Engel, P. Reid, Thermodynamics, Statistical thermodynamics and Kinetics, Pearson
10. E. S. R. Gopal, Statistical Mechanics and Properties of Matter, Ellis Horwood, England, 1974.

MCH-191: INORGANIC CHEMISTRY LAB I

L-T-P: 0-0-2 **Credit: 2**

- Quantitative analysis of metal ions in binary mixture by complexometric titrations
- Synthesis and characterization of different coordination complexes
- Separation and estimation of binary mixtures by ion-exchange method
- Separation of cations or anions in a mixture by paper chromatography

MCH-192: ORGANIC CHEMISTRY LAB I

L-T-P: 0-0-2 **Credit: 2**

- Detection and identification of organic compounds (solid/liquid) through chemical test.
- Separation of binary mixtures of solid-solid/liquid-solid/liquid-liquid organic compounds and identification of individual components

MCH-193: PHYSICAL CHEMISTRY LAB I

L-T-P: 0-0-2 **Credit: 2**

- Determination of specific rate constant of acid catalyzed hydrolysis of ester at two different temperature and evaluate the corresponding thermodynamic parameters
- Compare the strength of acids (HCl vs H_2SO_4) by studying the hydrolysis of ester
- Evaluate the energy of activation for saponification of ester
- Determination of rate constant of acid catalyzed hydrolysis of sucrose by a polarimeter
- To construct the phase diagram of three component systems
- Determination of heat of solution of oxalic acid from its solubility at different temperature
- Determination of isoelectric point
- Verification of adsorption isotherm by adsorption of acetic acid on charcoal
- Any other experiments related to thermodynamics, kinetics, adsorption and micelle performed in the laboratory during the semester

Recommended Books

1. A.I. Vogel, A Textbook of Quantitative Inorganic Analysis, ELBS
2. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry
3. G. N. Mukherjee, Handbook of Practical Chemistry
4. A.I. Vogel, A Textbook of Practical Organic Chemistry
5. A. M. James, F. F. Prichard, Practical Physical Chemistry
6. Shoermaker, Garland, Experimental Physical Chemistry

Detailed Syllabus of Second semester

MCH-201: INORGANIC CHEMISTRY-II

L-T-P: 3-1-0 **Credit: 4**

Unit 1: Elements of Group Theory

Symmetry elements (operations), Point group determination. Concept of groups and how it is related to chemistry. Groups, subgroups, classes, cyclic groups, group multiplication table. Matrix representation of symmetry elements. Construction of character tables. Character tables properties with the help of great orthogonality theorem. Splitting of orbitals in different symmetries. Mulliken symbols and their significance (A, B, E, T and their superscript subscripts).

Unit 2: Quantum Mechanical approach to Chemical Bonding

Valence bond theory for H_2 molecule. LCAO-MO and Huckel approximation to H_2^{2+}, H_2, homo and hetero diatomic, triatomic and polyatomic molecules/ions, application of V.B. and M.O. theories to diatomic and polyatomic molecules. Secular determinants. Koopmans' theorem, Molecular term symbols for homonuclear diatomic. Secular determinants construction for organic resonating π- systems (cyclic and non cyclic).

Unit 3: Organometallics-I

Concepts of 16 and 18 electrons rule for organometallic compounds and their applications. Reaction of organometallic complexes: substitution, oxidative addition, reductive elimination, insertion and elimination, electrophilic and nucleophilic reactions of coordinated ligands. Stereochemical non-rigidity and fluxional behaviour of organometallic compounds.

Unit 4: Bioinorganic Chemistry-I

Role of alkali and alkaline earth metal ions in biology; Na^+-K^+ Pump, ionophores and crown ethers. Metal site structure, function. Electron Transfer: Cytochromes, Iron-Sulfur Proteins and Copper Proteins. Oxygen transport and storage: Hemoglobin, myoglobin, hemerythrin, hemocyanin. Oxygen activation: Cytochrome P450, Cytochrome c oxidase. Chlorophyll and photosynthesis; PS-I, PS-II, oxygen evolving center.

Unit 5: Structure and Bonding in Boranes

Structure and bonding of higher boranes, Lipscomb's tropological diagrams and Wade's rules. Geometric and electronic structure, three-, four- and higher connect clusters, the *closo, nido, arachno*-borane structural paradigm, Styx No. of neutral and boron hydrides, Structure, synthesis and reactivity of the borane compounds.

Unit-6: Analytical Chemistry

Principle and application of Chromatography: thin-layer chromatography, size-exclusion chromatography, ion chromatography, gas chromatography, high performance Liquid chromatography and supercritical fluid chromatography.

Theory, instrumentation and applications of voltammetry, linear sweep voltammetry, anodic stripping voltammetry, cyclic voltammetry, amperometry, coulometry, electrogravimetry and polarography.

Theory, methodology and applications of thermogravimetric analysis (TGA), differential thermal analysis (DTA), and differential scanning calorimetry (DSC).

Recommended Books

1. F. A. Cotton, Chemical Applications of Group Theory
2. R. H. Crabtree, The Organometallic Chemistry of Transition Metals
3. B.D.Gupta and A.J. Elias, Basic Organometalltic Chemistry
4. I. Bertini, H. B. Grey, S. J. Lippard, J. S. Valentine, Bioinorganic Chemistry
5. Asim K. Das, Bioinorganic Chemistry
6. R. L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, Modern Methods of Chemical Analysis, 2nd Edition (1976), John Wiley, New York.
7. G. D. Christian, Analytical Chemistry, 5th Edition (1994), John Wiley & Sons, New York.
8. D.A. Skoog, Principles of Instrumental Analysis, 5th Edition (1998), Saunders College of Publishing, Philadelphia, London.
9. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry - An Introduction, 7th
10. Edition (2000), Saunders College Publishing, Philadelphia, London.
11. J. H. Kennedy, Analytical Chemistry: Principles, 2nd Edition (1990), Saunders Holt, London.
12. A. J. Bard, Electroanalytical Chemistry
13. J. W. Robinson, Atomic absorption Spectrometry
14. D. A. Skoog, D.M. West, F.J. Holler, Fundamentals of Analytical Chemistry
15. H. H. Willard, L. L. Meritt, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis
16. H.A. Strobel, Chemical Instrumentation: A Schematic Approach, 2nd Edition (1973)

MCH-202: ORGANIC CHEMISTRY II

L-T-P: 3-1-0 **Credit: 4**

Unit 1: Structural Effects on Reactivity

Linear free energy relationships (LFER), the Hammett equation, substitutent constants, theories of substitutent effects, interpretation of σ-values, reaction constant ρ, deviations from Hammett equation, dual - parameter correlations, inductive substituent constant, the Taft equation.

Unit-2: Organic Name Reaction

Birch reduction, Aldol condensation, Wittig reaction, Simmons-Smith cyclopropanation, Nef reaction, Favorskii reaction, Baeyer-Villiger oxidation, Claisen rearrangement, Beckmann rearrangement, Shapiro reaction, Mitsunobu reaction, Hofmann-Loffler-Freytag reaction, Barton reaction, Ene reaction, Mannich reaction, Stork enamine reaction, Michael addition, Robinson annulation, Barton decarboxylation and deoxygenation reaction, Sharpless asymmetric epoxidation, Norrish type-I & II reaction, di-pi methane rearrangement, paterno-Buchi reaction.

Unit-3: Reagents and Reactions

(i) Gilman's reagent–Lithium dimethylcuprate, (ii) Lithium diisopropylamide (LDA), (iii) Dicyclohexyl carbodiimide (DDC), (iv) 1,3-Dithiane (Umpolung reagent), (v) Peterson's synthesis, (vi) Bakers yeast, (vii) DDQ, (viii) Palladium catalysed reactions, (ix) Woodward and Prevost hydroxylation, (x) Iodotrimethyl silane.

Unit-4: The Disconnection approach

Basic principles, guidelines for disconnection with special emphasis on chemoselective, regioselective, stereoselective and stereospecific reactions, functional group inter conversion, synthon and reagent, synthetic equivalent, illogical electrophile and illogical nucleophile, Umpolong synthesis. designing synthesis of some target molecules with proper retrosynthetic analysis : Menthol, Taxol, Penicillin V, Reserpine, Progesterone, Estrone, Periplanone B, L-Hexoses etc.

Recommended Books

1. Clayden, Greeves, Warren, Organic Chemistry
2. F.A. Carey, R.J. Sundberg, Advanced Organic Chemistry
3. W. Carruthers, I. Coldham, Modern method of Organic Synthesis
4. Michael B. Smith, Jerry March, March's Advanced Organic Chemistry. Reactions, Mechanisms, and Structure
5. Jie Jack Li , Name Reactions: A Collection of Detailed Reaction Mechanisms
6. Bradford P. Mundy, Michael G. Ellerd, Frank G. Favaloro, Name Reactions and Reagents in Organic Synthesis
7. I. L. Finar, Organic Chemistry (Volume 1 & 2)

MCH-203: PHYSICAL CHEMISTRY II

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Quantum Mechanics

Origin of quantum mechanics, Black-body radiation, photoelectric effect, Compton effect, Pair production, de Broglie's hypothesis: Davisson-Germer's and Thomson's experiment, Wave-particle duality: Franck-Hertz experiment, Young's double slit experiment, Heisenberg's uncertainty principle.

Operators, Eigen functions, Hermitian operator, Postulates of quantum mechanics, Angular momentum, its commutative relations, Ladder operator, Pauli spin operator, Schrodinger wave equation and its formulation as an eigen value problem.

Translational motion of a particle, particle in one, two and three dimensional boxes, harmonic-oscillator, rotational motion of a particle: particle on a ring, particle on a sphere, rigid rotator, step-potential, tunneling, hydrogen atom.

Introduction to approximation methods: Perturbation theory and Variational method.

Unit-2: Electrochemistry

Quantitative treatment of Debye-Hückel theory of ion-ion interaction, its applications and limitations, modification of Debye-Hückel law for finite-sized ions, Debye-Hückel-Onsagar equation, association of ions: Bjerrum and Fuoss model, electrode kinetics, current-overpotential relationship, Tafel equation and its importance.

Recommended Books

1. I. N. Levine, Quantum Chemistry, 5th Edition (2000), Pearson Educ., Inc. New Delhi
2. Donald A McQuarrie, Quantum Chemistry, Viva Student Edition, Viva Books, NewDelhi
3. D. J. Grffiths, Introduction to Quantum Mechanics
4. J. L. Powell, B. Crasemann, Quantum Mechanics
5. D. A. McQuarrie, J. D. Simon, Physical Chemistry, A Molecular Approach, (1998), Viva Books, New Delhi
6. Richard L. Liboff, Introductory Quantum Mechanics
7. R.K. Prasad, Quantum Mechanics
8. Samuel Glasstone, An Introduction To Electrochemistry, Affiliated East-West Press Pvt. Ltd.-New Delhi (2000)
9. J. O'M. Bockris, A. K. N. Reddy, Modern Electrochemistry, Vol. 2 A & B, 2nd Edition, Plenum Press, New York (1998)

MCH-291: INORGANIC CHEMISTRY LAB II

L-T-P: 0-0-2 **Credit: 2**

- Qualitative analysis of mixture of compounds containing six radicals of which two are rare elements
- Tritrimetric estimation of mixtures of metal ions by EDTA
- Spectroscopic estimation of inorganic complexes
- Job's method of continuous variation

MCH-292: ORGANIC CHEMISTRY LAB II

L-T-P: 0-0-2 **Credit: 2**

- Small scale organic synthesis by exploiting common organic reactions**(**Nitration, Bromination, Condensation, Oxidation, Reduction , Esterification and Hydrolysis) and their purification (Recrystallization /Chromatography)

MCH-293: PHYSICAL CHEMISTRY LAB II

L-T-P: 0-0-2 **Credit: 2**

- Determination of rate constant of alkaline hydrolysis of ester conductometrically
- Conductometric titration of mixture of acids (HCl and CH_3CO_2H)
- Determination of the individual strengths of $(NH_4)_2SO_4$ and Na_2SO_4 in a mixture conductometrically
- Conductometric titration of Zn(II) vs $K_4[Fe(CN)_6]$ and determination of composition of the complex
- Determination of CMC of SDS conductometrically
- Potentiometric titration of mixture of acids (HCl and CH_3CO_2H)
- Determination of the formal redox potential of $Fe^{2+/}Fe^{3+}$ system potentiometrically
- Potentiometric titration of $K_4[Fe(CN)_6]$ by $ZnSO_4$ or $Pb(NO_3)_2$ and determination of composition of the complex
- Verification of Lambert and Beer's law. Also determine the concentration of an unknown solution from calibration curve
- Determination of pKin of bromocresol green indicator

Recommended Books

1. A.I. Vogel, Qualitative Inorganic Analysis
2. A.I. Vogel, A Textbook of Quantitative Inorganic Analysis, ELBS
3. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry
4. G. N. Mukherjee, Handbook of Practical Chemistry
5. A.I. Vogel, A Textbook of Practical Organic Chemistry
6. A. M. James, F. F. Prichard, Practical Physical Chemistry
7. Shoermaker, Garland, Experimental Physical Chemistry

Detailed Syllabus of Third semester

MCH-301: PRINCIPLES AND APPLICATIONS OF MOLECULAR SPECTROSCOPY

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Fundamentals

Interaction of electromagnetic radiation with matter, Einstein coefficient, transition probability, transition dipole moments and selection rules, intensity of spectral lines, line-widths and line shapes, Fourier transforms in spectroscopy.

Unit-2: Rotational and Vibrational spectroscopy

Classifications of molecules based on topicity, microwave and vibrational spectroscopy of diatomic and polyatomic molecules, energy levels, selection rules, isotope effect, non-rigidity on spectral features, vibration and group frequency, vibration-rotation spectra of diatomic molecules, origin of P, Q, and R branch, hot bands, applications.

Unit-3: Raman spectroscopy

Raman spectra of diatomic molecules, rotational and rotation- vibrational Raman transitions, effects of nuclear spin, polarization of Raman lines, applications.

Unit-4: Electronic spectroscopy

Origin, selection rules, spectral features, Franck-Condon principle, dissociation and pre-dissociation, rotational fine structure, charge transfer spectra, fluorescence and phosphorescence spectra, applications.

Unit-5: LASER

General features, principles, characteristics of laser, population inversion, basic elements in laser pulsed, lasers, laser cavity modes, Q-switching, mode locking, harmonic generation, different lasers: He-Ne, Nd-YAG, titanium-sapphire, dye lasers, semiconductor lasers, and applications of lasers in spectroscopy.

Unit-6: Photoelectron Spectroscopy

Photoexcitation and photoionization, core level (XPS, ESCA) and valence level (UPS) photoelectron spectroscopy, XPS and UPS of simple molecules, applications.

Unit-7: Nuclear Magnetic resonance spectroscopy

Basic principles, relaxation times, intensity of NMR signals, electronic shielding, NMR in liquids: chemical shifts, origin of spin-spin couplings, and qualitative idea about NMR spectra of AX, AX_2, A_3X and AB systems.

FT-NMR: Rotating frame of reference, effect of radiofrequency pulses, FID, Multi pulse operation, measurement of T_1 by inversion recovery method, spin echo and measurement of T_2.

Recommended Books

1. J. M. Hollas, Modern Spectroscopy, 4th edition (2004) John Wiley & Sons, Ltd., Chichester.
2. C. N. Banwell and E.M. Mc Cash, Fundamentals of Molecular Spectroscopy, 4th edition (1994), Tata McGraw Hill, New Delhi.
3. J. D. Graybeal, Molecular spectroscopy
4. I. N. Levine, Molecular spectroscopy
5. G. Herzburg, Infrared and Raman Spectra (1945), Spectra of Diatomic Molecules (1950), Van Nostrand, New York.
6. J. R. Lakowicz, Principles of Fluorescence Spectroscopy
7. W. Demtroder, Laser Spectroscopy
8. G. M. Barrow, Introduction to Molecular Spectroscopy, McGraw-Hill International Book Company, Tokyo, 1982.
9. R. K. Harris, Nuclear Magnetic Resonance Spectroscopy, (1986) Addison Wesley, Longman Ltd, London.
10. A Carrington and A. D. Mc Lachlan, Introduction to Magnetic Resonance, (1979) Chapman and Hall, London.

MCH-302: ADVANCED BIOINORGANIC AND ORGANOMETALLICS

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Bioinorganic II

Metal ion transport and storage: Ferritin, Transferrin, Siderophores and metallothionein. Role of alkaline earth metal ions in biological systems: (i) Catalysis of phosphatetransfer by Mg^{2+} ion, (ii) Ubiquitous regulatory role of Ca^{2+} in muscle contraction. Metalloenzymes**:** Urease, Hydrogenase, and Cyanocobalamine Catalase, peroxidase, superoxide dismutase, alcohol dehydrogenase, carbonic anhydrase, carboxypeptidase, xanthine oxidase, nitrogenase, vitamin B12 coenzyme.

Trace elements and their chemical speciation with special reference to Cu, Zn, Cd, Hg, Pb, Ag, Sb, Se, Ti, Si, Be etc. Toxic chemicals in air, water, soil, diet, fertilizer, their effects and remedial measures. Metal ion toxicity, metal dependent diseases, remedial measures, Bio-mineralogy.

Toxicity and drugs: Toxic effects of metal ions, detoxification by chelation therapy, metal dependent diseases and metal complexes as drugs, Pt, Ru, Rh and Au drugs.

Unit-2: Organometallics II

Application of 18- electron and 16- electron rules to transition metal organometallics, structure, bonding (pictorial mo-approach) and reactions of η2-ethylinic, η3-allylic and η5-cyclo-pentadineyl compounds, structure and bonding of carbonyls, nitrosyls and related pi- acids, alkyl, alkene, alkyne, π-allyl, polyene and cyclopolyene compounds; metal carbenes and carbynes, isolobal analogy, Dewar-Chatt model, oxophilicity, Agostic interaction, organo-metallic catalysts.

Catalysis by organometallic compounds: Wilkinson's catalyst, Tolman's catalytic loops; synthesis gas, water gas shift reaction, synthesis of methanol, hydroformylation (oxo process), hydrogenation of unsaturated compounds, Masanto acetic acid process, Waker process, synthetic gasoline, Fischer-Tropsch process; Polymerisation, oligomerisation and metathesis reactions of alkenes and alkynes; Zieglar-Natta catalysis.

Unit-3: Cluster, Cage, Ring of main group Transition-metal Clusters

Structure and bonding of higher boranes, Capping rules, metal-ligand complexes vs heteronuclear cluster, isolobal analogs of p-block and d-block clusters, closo, nido, arachno and Wade-Mingos rule. limitations and exceptions, clusters having interstitial main group elements, cubane clusters and naked or Zintl clusters, metal-carbonyl clusters, structures, capping and electron counting, molecular clusters in catalysis, clusters to materials, boron-carbides and metalborides, illustrative examples from recent literature. Metal-metal bonded complexes of transition metals (structure and bonding): dirhenium complexes, molybdenum blue, tungsten blue, tungsten bronze, ruthenium red, Creutz-Taube complex, transition metal dioxygen and dinitrogen complexes (structure, bonding and reactivity).

Unit-4: Inorganic Polymers

Classification, types of inorganic polymerization, comparison with organic polymers, Boron-oxygen and boron-nitrogen polymers, silicones, coordination polymers, sulphur-nitrogen, sulphur-nitrogen-fluorine compounds, binary and multi-component systems, hemolytic inorganic systems.

Recommended Books

1. M. N. Hughes, Inorganic Chemistry of Biological Processes, 2nd Ed.(1981), John-Wiley & Sons, New York.
2. W. Kaim and B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, An Introduction and Guide, Wiley, New York (1995).
3. S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, University Science Books, (1994).
4. I. Bertini, H. B. Grey, S. J. Lippard and J. S. Valentine, Bioinorganic Chemistry, Viva Books Pvt. Ltd., New Delhi (1998)
5. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Ed. (1999) John Wiley & Sons.
6. J. E. Huheey, Keiter and Keiter, Inorganic Chemistry.
7. R. H. Crabtree, The Organometallic Chemistry of Transition Metals, John Wiley.
8. Ch. Elschenbroich and A. Salzer, Organometallics, VCH.
9. J. P. Collman, L. S. Hegedus, J. R. Norton and R.G. Finke, Principles and Applications of Organotransition metal Chemistry, Univ. Sci. Books, Mill Valley. California.

MCH-303: ADVANCED ORGANIC SYNTHESIS I

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Radical Reactions in Organic Chemistry

Definition, generation of free radicals, detection, shapes and stability, stable free radicals. Example of addition, substitution, oxidation, cyclization and rearrangement involving radical reaction mechanism.

Unit-2: Protection and Deprotection Chemistry

The role of protective groups in organic synthesis, principle of protection and deprotection, Different procedure for protection and deprotection of hydroxyl (including 1,2- and 1,3-dihydroxy), phenols, amines, carbonyls and carboxylic groups.

Unit-3: Redox Reactions in Organic Synthesis

Fundamentals, *Oxidation of alcohols:* By Chromium and Manganese reagents, Silver carbonate, oxidation via alkoxysulphonium salts and other methods. *Oxidation of Carbon-Carbon double bonds:* dihydroxylation, diastereoselective epoxidation of homoallylic alcohols, photosensitized oxidation of alkenes, Pd-catalyzed oxidation of alkenes, use of Ruthenium tetroxide and Thallium (III) nitrate as oxidizing agents for organic substrate, other oxidizing agents. *Reduction by dissolving Metals*: reduction with metal and acid (reduction of carbonyl compounds), desulphurisation of thio-acetals, reduction of organic compounds by di-imide, low valent Titanium reagents, trialkyltin hydrides, trialkylsilanes and other reagents.

Unit-4: Natural Products

Biosynthesis of (i) Non-nitrogenous secondary metabolites from flavonoids and related polyphenolics, (ii) mono- and di-terpenoids from Mevalonic acid (iii) tri-terpenoids from geranyl pyrophosphate.

Structure and stereochemistry of alkaloids (Atropine/ Quinine); Terpenoids (Abietic acid/ β-Carotene); Steroids (Cholesterol). Biosynthesis of Atropine, Quinine, Abietic acid, β-Carotene, Cholesterol.

Recommended Books

1. Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2001.
2. M.B. Smith & Jerry March, March's Advanced Organic Chemistry, 5th Edition (2001), John Wiley & Sons, New York.
3. Peter Sykes, A Guide book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman Ltd., New Delhi.
4. S. M. Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, Ist Edition (1990), Macmillan India Ltd., New Delhi.
5. F.A. Carey and R.J. Sundburg,, Advanced Organic Chemistry, Part-A
6. F.A. Carey and R.J. Sundburg, Advanced Organic Chemistry, Part-B

MCH-304: ADVANCED QUANTUM MECHANICS

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Fundamental Principles

Postulates of quantum mechanics, Schmidt orthonormalisation, Fourier transformation, delta function with examples, tunneling, bound states, the Virial theorem.

Unit-2: Approximation Methods in Quantum Mechanics

Stationary perturbation theory for non-degenerate and degenerate systems and its applications to rotator, Stark effect, the Helium atom, Variation method, principles of linear and non-linear variation methods and its applications, JWKB approximation, time-dependent perturbation theory, radiative transitions, transition probability and rates, Einstein coefficients, selection rules.

Unit-3: Quantum Mechanics of Many Electron Atoms

Pauli's antisymmetry principle, antisymmetry of many electron wave function, spin and spatial orbitals, Slater determinant, closed-shell and open-shell electron configurations, multi-electron pure-spin state wave functions, formulation of a multi-electron closed-shell electron configuration energy, introduction of core, Coulomb and exchange integrals with their properties, independent particle model, multi-electron atomic Hartree Hamiltonian and related SCF equations solution, vertical ionization potential and Koopman's theorem, Hatree-Fock-Roothaan method for closed cell systems, Roothaan equation, discussion of electron correlation, Condon Slater rule.

Unit-4: Quantum Mechanics of Molecules

Born-Oppenheimer approximation, Valence bond theory, Molecular orbital treatment for homonuclear molecule, Hückel MO treatment of simple polyenes, separation of electronic and nuclear motion, basis sets for the molecular orbital calculations of polyatomic molecules, configuration interaction calculations of polyatomic molecules, illustrative examples of Ab initio HF and post HF calculations, atomic charge and bonding indices in polyatomic molecules.

Recommended Books

1. P. W. Atkins and R. S. Friedman, Molecular Quantum Mechanics, 3rd edition (1997), Oxford University Press. Oxford.
2. I. N. Levine, Quantum Chemistry, 5th edition (2000), Pearson Educ., Inc., New Delhi.
3. D. A. McQuarrie and J. D. Simon, Physical Chemistry: A Molecular Approach, (1998), Viva Books, New Delhi.
4. A. K. Chandra, Introductory Quantum Chemistry, 4th edition (1994), Tata McGraw Hill, New Delhi.
5. L. Pauling and E. B. Wilson, Introduction to Quantum Mechanics with Applications to Chemistry, (1935), McGraw Hill, New York.
6. G. C. Schatz and M. A. Ratner, *Quantum Mechanics in Chemistry*, Dover Publication, Inc, New York, 2002.
7. Richard L. Liboff, Introductory Quantum Mechanics
8. D. J. Grffiths, Introduction to Quantum Mechanics
9. J. L. Powell, B. Crasemann, Quantum Mechanics
10. R. K. Prasad, Quantum Mechanics

MCH-305: ADVANCED TOPICS IN INORGANIC CHEMISTRY I

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Molecular Orbital from Group theory

Introduction, transformation properties of atomic orbitals, Application of group theory in bonding theory. calculation of MO's of AB_n type, organic conjugated π and sandwich type molecules. Crystal field splitting in octahedral and tetrahedral complexes. M.O. construction of Octahedral Tetrahedral complexes. Splitting of MO level due to symmetry lowering (e.g. Jahn Teller Distortion)

Unit-2: IR and Raman Spectroscopy

Brief introduction to molecular vibrations, selection rules for fundamental transitions, symmetry of normal modes of molecules, Infrared and Raman activity of some typical molecules (molecules of C2v, C3v, C4v, D2h, D3h, D4h, Td and Oh point groups).

Unit 3: Inorganic Reaction Mechanism

General remark, complementary and non-complementary redox reactions, outer-sphere reaction, inner-sphere reaction, effect of bridging ligand in inner-sphere reaction, kinetics and mechanism, electron tunneling hypothesis, heteronuclear redox reaction and simplified Marcus theory, Marcus cross relationship and its application, remote attack, doubly-bridged process, ligand exchange, intervalence electron transfer, induced reaction, electron transport in biological systems and their simulations.

Substitution reactions in square planar, tetrahedral and octahedral geometries with special reference to d^n ion complexes: operational tests, aquation and anation, reactions without metal-ligand bond breaking, kinetics of chelate formation, reaction mechanisms of organometallic systems, studies on fast reactions, kinetic and activation parameters-tools to propose a plausible mechanism; stereochemical changes: types of ligand rearrangements, isomerism in 4-, 5- and 6-coordinated complexes; reactions of coordinated ligands: model choice of metal and ligand, acid-base reaction, hydrolysis of esters, amides and peptides, aldol condensation, trans-amination, template reactions, organic synthesis with special reference to macrocyclic ligand; reactions in fluxional organometallic compounds.

Recommended Books

1. F. A. Cotton and G.Wilkinson, Advanced Inorganic Chemistry, 6th Edn. (1999), John-Wiley & Sons,New York.
2. James E. Huheey, Inorganic Chemistry, 4th Edn. (1993), Addison Wesley Pub. Co., New York
3. N. N. Greenwood and A. Earnshaw, Chemistry of the Elements, 2nd Edn. (1997), Butterworth Heinemann, London.
4. F. A. Cotton, Chemical Applications of Group Theory, 3rd Edn. (1999), John Wiley & Sons,
5. New York.
6. G. L. Miessler and D. A. Tarr, Inorganic Chemistry, 2nd Edn. (1999), Prentice Hall International Inc., London.
7. K. Veera Reddy, Symmetry and Spectroscopy of Molecules, New Age International Pvt. Ltd., New Delhi (1999).
8. A. Vincent, Molecular Symmetry and Group Theory, John Wiley & Sons, New York, 1998.
9. D. M. Bishop, Group Theory and Chemistry, Oxford University. Press, 1993.
10. V. Heine, Group Theory in Quantum Mechanics: An Introduction to Its Present Usage, Dover Publication, New York, 1991.
11. R. McWeeny, Symmetry: An Introduction to Group Theory and Its Applications, Dover Publications, New York.

MCH-306: BIOCHEMISTRY, PERICYCLIC AND PHOTOCHEMISTRY

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Proteins and Nucleic Acids

Natural and synthetic amino acids, different synthetic strategy of peptides, structure and function of protein and nucleic acids, Ramachandran plot, denaturation of proteins, factors affecting denaturation, protein folding, doble helical structure of DNA, RNA, various forms of DNA (a, b, c, z) and RNA (m, r & t).

Unit-2: Enzymes, Carbohydrates, Lipids, Hormones, Steroids and Bioenergetics

Classification, function and regulation of enzymes, active sites, Vitamins as coenzymes and co-factors, enzyme kinetics. Structure, function and reactions of carbohydrates, lipids, hormones and steroids; Cholesterol, Prostaglandins, and cell membranes. Glycolysis, citric acid cycle, electron transport chain, oxidative phosphorylation.

Unit-3: Pericyclic Reaction

Introduction, phase and symmetry of orbitals, types of pericyclic reactions; Cycloaddition reactions: FMO-approach, co-relation diagram, Woodward-Hoffmann selection rules, regioselectivity, secondary orbital interaction, Lewis acid catalysis, site selectivity, Electrocyclic reactions: FMO-approach, electroreversion, stereochemical effects, Woodward-Hoffmann rules, Sigmatropic rearrangement: definition, types of sigmatropic reactions, FMO-approach, selection rules, Ene reaction: FMO-approach for ene reactions.

Unit-4: Organic Photochemistry

Basic Principles, Cis-trans mechanism, photo chemical reactions of carbonyl compounds, olefins and conjugated carboyl compounds, photo induced functionalisation of organic molecules involving Norrish type, Paterno Buchi Reaction, di-π- methane rearrangement, photo reduction of ketones.

Recommended Books

1. S.M. Mukherjee and S.P. Singh, Pericyclic Reactions &Photochemistry, MacMillan India, New Delhi.
2. I. Fleming, Pericyclic Reactions, Oxford University Press, Oxford (1999).
3.Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2001.
4. M.B. Smith & Jerry March, March's Advanced Organic Chemistry, 5th Edition (2001), John Wiley & Sons, New York.
5. S. M. Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, Ist Edition (1990), Macmillan India Ltd., New Delhi.
6. D. Nasipuri, Stereochemistry of Organic Compounds, 2nd Edition (1994), Wiley Eastern Ltd., New Delhi.
7. L. Stryer, Biochemistry, 5th edition (2002), Freeman & Co., New York.
8. D. L. Nelson and M. M. Cox, Lehninger, Principles of Biochemistry, 3rd edition (2002) McMillan North Publication.

MCH-307: SOLID STATE CHEMISTRY

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Crystal structure and X-ray Diffraction

Definitions related to crystal structure, reciprocal lattice, Brillouin Zones, structure factor, Laue equations and Bragg's law, X-ray diffraction experiments: powder method and single crystal method.

Unit-2: Solid State Reactions & Phase transitions

General principles and experimental procedure of solid state reactions, growth of single crystals: Czochralski method, Bridgman and Stockbarger methods. Thermodynamic and Burger's classification of phase transition, kinetics of phase transition, nucleation and growth.

Unit-3: Free electron & Band Theory of Solids

Free electron gas model of metals, free electron gas in a one-dimensional and three dimensional box, Bloch theorem, Kronig-Penny model, tight binding approximation, Band theory of insulators and semiconductors, intrinsic semiconductors, extrinsic semiconductors, doped semiconductors, rectifiers, transistors, p-n junctions and their applications, Schottky and Frenkel defects, stoichimetric imbalance, origin of colours.

Unit-4: Thermal & Magnetic Properties of Solids

Electronic specific heat, lattice heat capacity, Hall effect, Einstein theory, Debye theory, Born's modification of the Debye theory. Origin and classifications of magnetic substance, magnetic moment, ferromagnetic, antiferromagentic and ferromagnetic ordering, magnetic susceptibility, Curie and Cuire-Weiss law, super exchange, magnetic domains, and hysteresis.

Recommended Books

1. C. Kittel, Introduction to Solid State Physics, John Wiley & Sons, Inc., New York, Chichester.
2. O. Madelung, Introduction to Solid State Theory
3. A. R. West, Solid State Chemistry and its Applications, (1984) John Wiley and Sons, Singapore.
4. L.V. Azaroff, Introduction to Solids, (1977) Tata McGraw-Hill, New Delhi.
5. A. J. Dekker, Solid State Physics, Prentice Hall

ELECTIVE 1

MCH-308: SUPRAMOLECULAR CHEMISTRY AND DRUG DESIGN

L-T-P: 2-0-0 **Credit: 2**

Unit-1: Supramolecular Chemistry

Fundamentals: definitions of supramolecular chemistry, host-guest chemistry, chelate and macrocyclic effects, preorganisation, thermodynamic and kinetic selectivity, supramolecular interactions (i..e. cation –π, π-π etc.), cation, anion and neutral molecule binding: crown ethers, podands/ lariat ethers, spherands, cryptands, complexation of organic cations, calixarenes, cation host to anion host, shape selectivity, guanidinium receptors, coordination interactions, cavitands: cyclodextrins and molecular tweezers. molecular switches.

Catenanes, rotaxanes and molecular knots: Self assembly and templates, strict self assembly and self assembly with covalent modification, electrostatic and H-bonding effects in templating, catenanes/ catenands/ catenates, rotaxanes/ pseudo-rotaxanes, metal templates for catenanes (Sauvage), π stacking in catenane and rotaxane formation (Stoddart), helicates and molecular knots. *Molecular devices:* history and future of nanoscale machines, relation to host-guest chemistry (definition of supramolecular device), supramolecular photochemistry, photo- and electro-chemical sensors, dendrimers, molecular device components, machines based on catenanes/ rotaxanes, chemically assembled electronic nanocomputing.

Unit-2: Drug Design and Antineoplastic Agent

Concept of pharmacodynamics, d*rug targets:* enzymes, receptors, nucleic acids; c*oncept on pharmacokinetics:* drug absorption, distribution, metabolism and excretion, concept on lead compound and lead modification, pharmacophore, concept of prodrug and soft drug, structure activity relationship (SAR), factors affecting bioactivity; *Antineoplastic agents*: synthesis and mode of action of mechlorethamine, cyclophosphamide, melphalan, and 6-mercaptopurine. *Cardiovascular drugs:* introduction to cardiovascular diseases, synthesis and mode of action of amyl nitrate, sorbitrate, diltiazem, quinidine, verapamil, methyl dopa; *local antiinfective drugs and antibiotics:* synthesis and mode of action of sulphonamides, nalidixic acid, norfloxacin, aminosalicyclic acid, ethinamide, fluconazole, chloroquin and premaquin; *Antibiotics*: cell wall biosynthesis, inhibit-lactam rings, synthesis of penicillin.

Recommended Books

1. J. M. Lehn, Supramolecular Chemistry- Concepts and Perspectives
2. S chneider, H. J., Yatsimirski, Principles and Methods in Supramolecular Chemistry
3. Advanced Organic Chemistry, Part-A, F.A. Carey and R.J. Sundburg
4. Advanced Organic Chemistry, Part-B, F.A. Carey and R.J. Sundburg
5. I. L. Finar, Organic Chemistry (Volume 1 & 2)

MCH-309: NUCLEAR CHEMISTRY

L-T-P: 2-0-0 **Credit: 2**

Unit-1: Theory of radioactive decay

Quantum mechanical aspects of radioactive disintegration, alpha decay paradox and its explanation in terms of tunnel effect, Geiger-Muller relationship, time-dependant perturbation theory, Golden rule and its application in explaining beta and gamma transition, selection rules.

Unit-2: Nuclear force and structures

Two body problem - properties of deuteron and derivation of depth-range relationship, its applications in explaining nature of nuclear force, elementary particles; nuclear models - strong and weak interaction, nuclear magnetic dipole moment and electric quadruple moment in terms of shell model, collective model, Fermi gas model.

Unit-3: Nuclear reactions general features

Types of nuclear reaction, conservation laws, nuclear reaction dynamics, mechanism of nuclear reaction, use of uncertainty principle, resonance and non-resonance reaction, optical model and calculation of mean free path, nuclear fission and fusion reaction, calculation of fission probability from Bohr-Wheeler's theory Centre of mass system and laboratory co-ordinate.

Unit-4: Nuclear detectors

Classification of nuclear detectors, G. M. detector-operational principle, dead time, proportional detectors: proportional counter performance, flow-type proportional counter, gas multiplication factor, scintillation detectors: different types with examples, pulse shape analysis, resolution and detection efficiency, liquid scintillation detectors, detection of neutrons, semiconductor detector: general characterization, depletion depth, reverse bias, requirement of cryogenic condition, resolution and efficiency, pulse rise time, with a brief account of n-type and p-type semiconductor, Si lattice, Ge-Li, Si-Li - a comparison intrinsic and doped-semiconductor-fabrication surface barrier detector; some basic ideas of pulse processing and shaping, single- and multi-channel analysers, digital and analogue systems, applications in space research, development of detector assembly with requirement of newer space and defence technology viz., nuclear missile, Coincidence counting Determination of absolute disintegration rates, decay scheme studies.

Recommended Books

1. B. Harvey, Introduction to Nuclear Physics and Chemistry, Prentice Hall, New York, 1965.
2. H. J. Arnikar, Essentials of Nuclear Chemistry, 4th Edn Reprint, New Age International (P) Ltd Publications, New Delhi, 2001.
3. G. R. Choppin and J. Rydberg, Nuclear Chemistry: Theory and Applications, Pergamon, Oxford, 1980.
4. D. D. Sood, A.V. R Reddy and N. Ramamoorty, Fundumentals of Radiochemistry, Yancas, Mumbai, 2004.

MCH-391: INORGANIC CHEMISTRY LAB III

L-T-P: 0-0-4 **Credit: 4**

- To study the kinetics of different inorganic reactions by conductometric, colorimetric, and spectrophotometric method
- Estimation of selected ores, minerals, and alloys
- Synthesis and characterization of different coordination complexes

MCH-392: ORGANIC CHEMISTRY LAB III

L-T-P: 0-0-4 **Credit: 4**

- Thin Layer Chromatography (TLC, preparation of TLC plates, analysis), identification.
- Column Chromatography (packing, running), separation.
- Extraction of Renewable chemicals from plants: Take a particular part of a plant such as fruit/ leaf/bark/ heavy wood etc. Extraction and Purification and charecterisation.
- Quantitative Estimation of: (a) Sugars (Glucose, Cane sugar), (b) Phenol, (c) Aniline, (d) Nitrogen by Kjldahl method.

MCH-393: PHYSICAL CHEMISTRY LAB III

L-T-P: 0-0-4 **Credit: 4**

- Computer programming
- Energy minimization techniques by utilization of software
- Utilization of molecular geometry optimisation software for modelling of small molecules

Recommended Books

1. A.I. Vogel, Qualitative Inorganic Analysis
2. A.I. Vogel, A Textbook of Quantitative Inorganic Analysis, ELBS
3. Ghosal, Mahaparta and Nad, An Advanced Course in Practical chemistry
4. G. N. Mukherjee, Handbook of Practical Chemistry
5. A.I. Vogel, A Textbook of Practical Organic Chemistry
6. A. M. James, F. F. Prichard, Practical Physical Chemistry
7. Shoermaker, Garland, Experimental Physical Chemistry

Detailed Syllabus of Fourth semester

MCH-401: SPECTROSCOPY FOR STRUCTURE ELUCIDATION

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Ultra-Violet & Infrared Spectroscopy

Absorption of dienes, polyenes, carbonyl compounds and α,β-unsaturated carbonyl compounds, Woodward rule and its applications. Different vibration modes, bond stretching, absorption region of functional groups, electrical and steric effects, effects of hydrogen bonding, Fingerprint region and interpretation of IR spectra.

Unit-2: NMR Spectroscopy

Principles, relaxation phenomenon, chemical shifts, coupling constants, spin-spin interactions, simplification of complex spectrum, spin decoupling, nuclear Overhauser effect, detailed interpretation of ^{1}H NMR, ^{13}C NMR, DEPT, two dimensional NMR: COSY, NOESY.

NMR spectra of paramagnetic coordination compounds, dipolar and contact shifts, ^{11}B, ^{19}F, ^{27}Al, and ^{31}P – NMR spectroscopy with typical examples.

Unit-3: Mass Spectroscopy

Principles, different techniques, fragmentation modes, factors influencing ion abundance, rearrangements, cleavage associated with common functional groups, molecular and metastable ion peak, Nitrogen rule and interpretation of mass spectra.

Combined applications of different spectroscopic techniques (UV, IR, NMR, Mass) in elucidation of structure.

Unit-4: EPR & Mössbauer

Origin, principle, hyperfine splitting, factors affecting the magnitude of g-value, anisotropy in hyperfine coupling constants, zero-field splitting, Kramers' degeneracy, nuclear quadrupole interactions, Mössbauer effect, isomer shift, quadrupole splitting, typical spectra of iron and tin compounds, NQR.

Unit-5: Optical Rotatory Dispersion & Circular Dichroism

Principles of ORD and CD, different techniques, Cotton effect, Faraday and Kerr effects, applications in determining absolute configuration of metal complexes, amino acids and proteins.

Recommended Books

1. R. M. Silverstein and F.X. Webster, Spectroscopic Identification of Organic Compounds, 6th Edition (2003) John Wiley, New York.
2. D. H. Williams and I.F. Fleming, Spectroscopic Methods in Organic Chemistry, 4th Edition (1988), Tata-McGraw Hill, New Delhi.
3. P. Y Bruice, Organic Chemistry, 2nd Edition (1998) Prentice-Hall, New Delhi.
4. E. A. V. Ebsworth, D. W. H. Rankin and S. Cradock, Structural Methods in Inorganic Chemistry, 1st Edition (1987), Blackwell Scientific Publications, Oxford, London.
5. R. S. Drago, Physical Methods in Chemistry, International Edition (1992), Affiliated East-West Press, New Delhi.
6. R. S. Drago, Physical Methods in Inorganic Chemistry, 1st Edition (1971), Affiliated East-West Press, New Delhi.

MCH-402: ADVANCED TOPICS IN INORGANIC CHEMISTRY II

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Magnetochemistry

Vector atom model and relation between orbital angular momentum and dipole moment. Spectroscopic term determination. Splitting of term due to spin orbit coupling. Types of magnetic materials, magnetic susceptibility and its determination. diamagnetism in atoms and polyatomic systems, Pascal's constants, Lande interval rule, energies of J states, Curie equation, Curies law and Curie-Weiss law, First order and second order Zeeman effects, temperature independent para magnetism, simplification and application of Van Vleck susceptibility equation, Gouy, Faraday and Evans methods, vibrating sample magnetometer, SQUID and NMR methods. Magnetic anisotropy, quenching of magnetic moments of transition metal compounds in cubic and axially symmetric crystal fields, low spin- high spin crossover, magnetic behavior of Lanthanides and Actinides, magnetic exchange interactions, magnetic materials.

Unit 2: Solid State Chemistry and X-ray Crystallography

The geometry of crystalline state; Nature and generation of X-rays, Production of monochromatic X-rays, Scattering of X-rays, Diffraction of X-rays by crystals, Bragg's law, 1, 2 and 3 dimensional Laue equations, atomic scattering factor, structure factor, systematic absences, Unit cell-primitive and non-primitive unit cells, unit cell parameters and crystal systems. Miller indices. Crystallographic symmetries. Crystallographic Point group. Space group-Hermann–Mauguin notations, Determination of space groups and crystal structures.

Bonding in metal crystals: free electron theory, electrical conductivity, band theory, band gap, metal and semi-conductors – intrinsic and extrinsic semiconductors; semiconductor/metal transition, p-n junctions, superconductivity, Bardeen, Cooper and Schriefer (BCS) theory. Defects in solids.

Unit-3: Photochemistry of Transition Metal Complexes

Photoreactions of complexes of Cr(III) and Co(III), photo-aquation, photo-substitution and photo-racemization, photochemistry of $Ru(bpy)_3^{2+}$ and its application as photocatalyst for photo-splitting of water, photochemistry of transition metal carbonyls complexes.

Recommended Books

1. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn. (1999), John-Wiley & Sons, New York.
2. N. N. Greenwood and A. Earnshaw, Chemistry of the Elements, 2nd Edn. (1997), Butterworth
    a. Heinemann, London.
3. F. E. Mabbs and D. J. Machin, Magnetism and Transition Metal Complexes, Dover Publications, New York, 2008.
4. 4.O. Kahn, Molecular Magnetism, VCH, New York, 1993.
5. P. Day and A. E. Underhill (Eds), Metal-organic and Organic Molecular Magnets, RSC, London, 2000.
6. J. S. Miller and M. Drillon (Eds), Magnetism: Molecules to Materials, V; Molecule-based Magnets, Wiley-VCH, Weinheim, 2005.
7. B. D. Cullity and C. D. Graham, Introduction to Magnetic Materials, 2nd Ed, John Wiley & Sons, New York, 2011.
8. D. M. Roundhill, Photochemistry and Photophysics of Metal Complexes, Plenum Press, New York and London (1994).
9. G. J. Ferraudi, Elements of Inorganic Photochemistry, John Wiley & Sons (1988).
10. V. Balzani and V. Carassiti, Photochemistry of Coordination Compounds, Academic Press, London (1970).
11. O. Horvath and K.L. Stevenson, Charge Transfer Photochemistry of Coordination Complexes, VCH Publishers Inc. (1993)

MCH-403: ADVANCED ORGANIC SYNTHESIS II

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Green Organic Synthesis

The background of organic synthesis, The need of green chemistry, Principles of green chemistry, Concept of atom economy Tools of green Chemistry – microwave, ultra sound, ionic liquids, supercritical H_2O and CO_2 as solvents, etc. Concept of organocatalyst, Green Chemistry in real world cases and planning green synthesis in chemical laboratory.

Unit-2: Asymmetric Synthesis

Introduction, kinetic and thermodynamic principles to asymmetric synthesis, diastereoselective & enantioselective synthesis; *Methods of asymmetric synthesis:* Resolution, use of chiral pool, chiral auxiliaries, use of stoichiometric chiral reagents, asymmetric catalysis. Asymmetric hydrogenation with special reference to Ru-BINAP catalysts, asymmetric reduction of prochiral ketones with Baker's Yeast & CBS-catalyst, asymmetric epoxidation with special reference to Sharpless and Jacobsen epoxidation, asymmetric diethylzinc addition to carbonyl compounds, asymmetric aldol reactions, asymmetric Michael reaction; industrial applications of asymmetric synthesis.

Unit-3: Organometallic Chemistry

Preparation, properties and reactions of Organomagnesium, Organolithium and Organozinc reagents in synthesis. The role of Boron, Silicon, Sulphur and Phosphorus in organic synthesis. Principle, preparation, properties and application of some transition metals in organic synthesis with special reference to Copper, Palladium, Cobalt, Titanium and Nickel.

Unit-4: Heterocyclic Chemistry

1,2- and 1,3-azoles: Synthesis/ reactions/ applications, Comparison of azoles (1,2- / 1,3-) with other related mono-heterocycles. *benzo-fused five and six-membered heterocycles:* synthesis and reactions including medicinal applications of benzopyrroles, benzofurans, benzothiophenes, quinolizinium and benzopyrylium salts, coumarins and chromones; heterocycles in pharmaceutical industry.

Recommended Books

1. Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2001.
2. M.B. Smith & Jerry March, March's Advanced Organic Chemistry, 5th Edition (2001), John Wiley & Sons, New York.
3. R. O. C. Norman and J. M. Coxon, Principle of organic synthesis
4. S. Warren, Organic synthesis: The disconnection approach
5. W. Carruthers, Modern methods of organic synthesis
6. Paul. T. Anantas and Tracy C. Williamson, Green Chemistry
7. Theory and Practice, Paul T. Anastas and John C. Warner, Green Chemistry
8. J. A. Joule and K. Mills: Heterocyclic Chemistry (4 th Edition)

MCH-404: ELECTROCHEMISTRY AND STATISTICAL MECHANICS

L-T-P: 3-1-0 **Credit: 4**

Electrochemistry

Unit-1: Ion-Solvent interaction

Born model and Born equation, enthalpy of ion-solvent interaction and its evaluation, Eley-Evan model, solvation number and its determination.

Unit-2: Electrical double Layer

OHP and IHP, potential profile across double layer region, potential difference across electrified interface, structure of the double layer**:** Helmholtz-Perrin, Gouy-Chapman, and Stern models, Butler-Volmer equation under near equilibrium and non-equilibrium conditions, exchange current density, Tafel plot, thermodynamics of double layer, electrocapillary equation, determination of surface excess and other electrical parameters.

Unit-3: Electrode Kinetics

Polarizable and non-polarizable interfaces, multistep reactions: a near equilibrium relation between current density and over potential, concept of rate determining step, determination of reaction order, stochiometric number, transfer coefficient.

Statistical Mechanics

Unit-4: Ensembles and Partition function

Probability, Equal a priori probability, concept of ensemble, Micro/Macro/Grand-canonical ensemble, Ergodic hypothesis, phase space, quantization of phase space, Liouville theorem, review of rotational, vibrational and translational partition functions, entropy of a two level system, Gibbs paradox, equipartition of energy, applications of partition function to specific heat of solids, chemical equilibrium ideal and real gases.

Unit-5: Quantum statistics

Bose-Einstein distribution law, Einstein condensation, thermodynamic properties of ideal BE gas, Fermi-Dirac distribution law, degenerate Fermi gas, electron in metals, magnetic susceptibility, fluctuation in ensembles, concentration fluctuation.

Recommended Books

1. J. O'M. Bockris and A. K. N. Reddy, Modern Electrochemistry, Vol. 1 & 2A and 2B, (1998) Plenum Press, New York.
2. A. J. Bard and L. R. Faulkner, Electrochemical Methods: Fundamentals and Applications, 2nd edition, (2001) John Wiley &Sons, New York.
3. Samuel Glasstone, An Introduction to Electrochemistry: Edition 1st, East-West Press Pvt Ltd New Delhi, India.
4. S. R. Morrison, Electrochemistry in Semiconductor and Oxidised Metal Electrodes, Plenum Press, New York, 1980.

5. D. E. Kyriacou and D. A. Jannakoudis, Electrocatalysis for Organic Synthesis, Wiley, New York, 1986.
6. J. Goodisman, Electrochemistry: Theoretical Foundations, Wiley, New York, 1987.
7. J. O'M. Bockris and S. U. M. Khan, Surface Electrochemistry, Plenum Press, New York, 1993.
8. C. M. A. Brett and A. M. O. Brett, Electrochemistry: Principles, Methods and Applications, Oxford University Press, Oxford, 1993.
9. P. W. Atkins, Physical Chemistry, 5th Edn, Oxford University Press, Oxford, 1994.
10. K. V. Kordesch, Fuel Cells and Their Applications, VCH, Weinheim, 1994.
11. B. K. Agarwal and M. Eisner, Statistical Mechanics, (1988) Wiley Eastern, New Delhi
12. D. A. McQuarrie, Statistical mechanics, (1976) Harper and Row Publishers, New York
13. E. S. R. Gopal, Statistical Mechanics and Properties of Matter, Ellis Horwood, England, 1974
14. S. K. Ma, Statistical Mechanics, World Sci, Singapore, 1985
15. R. K. Pathria, Statistical Mechanics, Butterworth-Heinemann, 1996
16. B.B. Laud, Statistical Mechanics

ELECTIVE-II

MCH-405: POLYMER CHEMISTRY

L-T-P: 2-0-0 **Credit: 2**

Introduction, classification, different molecular weights and their determination, glass transition temperature, crystallinity, mechanical properties, polymerization techniques, detailed kinetics study of condensation and addition polymerization, Carothers equation, chain transfer agents and their utility, Mayo equation, controlled/living polymerization techniques and their applications: criteria, classifications, anionic, cationic, group transfer, radical: NMP, RAFT, ATRP, degenerative transfer polymerization, TERP, metal free thermal and photo-polymerization, co-ordination polymerization, metallocene polymerization, concept of copolymerization, copolymer equation, Q-e scheme, Dendrimers: synthetic strategy, molecular weight and branching calculation, properties and applications, Hyperbranched polymers synthesis and importance, sequence and stereo-controlled polymer synthesis, properties of polymers in solutions, Flory-Huggins model, viscoelastic properties of polymers, polymer modification and manufacturing of commodity polymers: grafting, cross-linking, blending, compounding.

Specialty polymers: Liquid crystalline polymers, conducting polymers: synthesis, mechanism of conduction and applications, electroluminescent polymers, inorganic polymers, biomedical polymers, rubber chemistry, biodegradable polymers, and hybrid materials based on polymers.

Recommended Books

1. G. Odian, Principles of Polymerization, 3rd Edition (1991), John Wiley, Singapore
2. F. W. Billmayer, Jr., Text Book of Polymer Science, 3rd Edition (1984), Willey-Interscience, NY
3. C. Tanford, Physical Chemistry of Macromolecules
4. P. Bahadur, N.V. Sastry, Principle of Polymer Sciences, Narosa Publishing House, New Delhi
5. V.R. Gowarikar, N.V. Vishwanathan, J. Shreedhar, Polymer Sciences, Wiley Eastern, New Delhi
6. P. W. Atkins, Physical Chemistry, 8th Edition, Oxford University Press, New York
7. P. J. Flory, Polymer Chemistry

MCH-406: ADVANCED SPECTROSCOPY

L-T-P: 2-0-0 **Credit: 2**

Unit-1: Fundamentals

Generation of singlet and triplet states, radiative and non-radiative transitions, fluorescence, phosphorescence, quantum yield and life-time measurements, fluorescence quenching, resonance energy transfer, solvation dynamics.

Unit-2: Lasers in Spectroscopy

Brief review of laser action, application of lasers as excitation source, time resolved fluorimetry, transient absorption spectroscopy, surface plasmon spectroscopy, multiphoton spectroscopy, single molecule spectroscopy, fluorescence correlation spectroscopy, upconversion, microscopy (optical, phase contrast, confocal, FLIM), SERS, and CARS.

Unit-3: Photophysical Processes

Unimolecular processes, delayed fluorescence, kinetics of bimolecular processes: collision quenching, Stern-Volmer equation, concentration dependence of quenching and excimer formation, excited state electron transfer processes: exciplex, twisted intramolecular charge transfer processes, proton couple electron transfer processes, special photochemical reactions, flash photolysis, laser flash photolysis.

Recommended Books

1. J. M. Hollas, Modern Spectroscopy, Wiley, New York, 1996.
2. D. N. Sathyanarayana, Electronic Absorption Spectroscopy and Related Techniques, University Press, 2001.
3. G. Aruldhas, Molecular Structure and Spectroscopy, 2nd Edn, Prentice-Hall of India, New Delhi, 2007.
4. G. M. Barrow, Introduction to Molecular Spectroscopy, McGraw-Hill International Book Company, Tokyo, 1982.
5. J. D. Graybeal, Molecular Spectroscopy, McGraw-Hill International Editions, Spectroscopy series, 1998.
6. J. R. Lakowicz, Principles of Fluorescence Spectroscopy
7. R. Schinke, Photodissociation dynamics
8. W. Demtroder, Laser spectroscopy
9. R. D. Levine, Molecular Reaction Dynamics
10. J. I. Steinfeld, J. S. Francisco, W. L. Hase, Chemical Kinetics and Dynamics

ELECTIVE-III

MCH-407: MATERIALS CHEMISTRY

L-T-P: 2-0-0 **Credit: 2**

Introduction, importance, classifications and theoretical aspect of nanomaterials, top down-bottom up approach, different synthetic strategy of metal/metal oxide/semiconducting materials, template based synthesis, size, shape and dimension controlled synthesis, growth kinetics, composite nanostructures, properties and size effect of nanomaterials in optoelectronic, mechanical, magnetic, and catalytic properties, applications of nanomaterials in energy, electronics, automobiles, textiles, cosmetics, nanobiotechnology, nanosensors, nanomedicines, nanophotonics space and defense, etc.

Different Instrumental Techniques for characterization: Basic principles and applications of X-ray diffraction, electron microscopies (SEM, TEM), scanning probe microscopies (STM), atomic force microscopy (AFM), optical microscopies [confocal microscopy, scanning near field optical microscopy, particle size analysis (DLS)], thermal (DSC, DTA), optical (IR, FTIR, Raman) and XPS.

Recommended Books

1. C. N. R. Rao, A. Müller, A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Vols 1 and 2, Wiley-VCH, Weinheim, 2004
2. C. Bréchignac, P. Houdy, M. Lahmani, Nanomaterials and Nanochemistry, Springer, London, 2006.
3. G. Cao, Nanostructures & Nanomaterials, Synthesis, Properties & Applications, Imperial College Press, London, 2004. L. Cademartiri and G. A. Ozin, Concepts of Nanochemistry, Wiley-VCH, Weinheim, 2009.
4. C. N. R. Rao, A. Muller and A. K. Cheetham, Nanomaterials Chemistry: Recent Developments and New Directions, Wiley-VCH, Weinheim, Germany, 2007.
5. G.A. Ozin, A. C. Arsenault and L. Cadematiri, Nanochemistry: A Chemical approach to Nanomaterials, Royal Society of Chemistry, London, 2009.

MCH-408: INDUSTRIAL CHEMISTRY

L-T-P: 2-0-0 **Credit: 2**

Unit 1: Materials for Electronic Industry

High purity Silicon, Germanium, Gallium Arsenide (GaAs) Indium phosphide (InP) etc. preparation using Zone refining, crystal growth and there use in electronic industry. High temperature materials, high alumina, alumina, sic, chromite, zirconia, magnesite etc. Ionic and superionic conductors, alumina oxide ion conductors, halide conductors superionic, fast ion conductors- RbbAg4I5, Arrhenious equation.

Unit 2: Fertilizer Industries

General Principles of plant Nutrition: Essential plant nutrients, functions of the essential elements, classification of commercial nitrogenous fertilizers, manufacturing of ammonium sulphate, Urea, ammonia nitrate commercial phosphatic fertilizers. Manufacturing process and properties of phosphatic fertilizers, single super phosphate, triple super phosphate.

Commercial potassic fertilizers: Chemicals of potassium compounds, classification, manufacturing process and properties of potasium fertilizer, mariate of potassium, potassium sulphate, mixed fertilizer.

Biofertilizers: Classification, demands and production, Present status of fertilizer Industries in India.

Unit 3: Glass and Ceramics

Physical and chemical properties of glasses, raw materials, manufacturing of special glasses, ceramics and their properties, raw materials, manufacturing of ceramics, applications of colours to pottery, use of ceramics.

Unit 4: Utility Chemicals

Manufacturing and industrial uses of H_2 O_2, N_2, CO_2, Cl_2 & acetylene gases. Liquefaction of gases, production of low temperature.

Inorganic fine chemicals, magnesia, alumina, $AlCl_3$, calcium carbonate, sodium silicate, MnO_2, $FeSO_4$, PbO_2 and NaOH etc.

Recommended Books

1. H. V. Keer, Principles of Solid state.
2. A. R. West, Solid State Chemistry and its applications, John Wiley & Sons, 2003.
3. B. K. Sharma, Engineering chemistry, Krishna Prakashan Media.
4. Industrial chemistry, B. K. Sharma.
5. Engineering chemistry, B. K. Sharma.
6. S. D. Shukla & G N Pandey: A text book of chemical technology Vol. 1
7. F A. Henglein: Chemical Technology (Pergamon)
8. D. Patranabis, Sensors and Transdusers, 2nd Edn, Prentice, Hall of India (2003).
9. Rajankumar Basak, Fertilizers, A text Book

MCH-491: DISSERTATION

L-T-P: 0-0-6 **Credit: 6**

- Recent research articles will be supplied to each student for study followed by critical discussion on the research paper.
- Research problem has to be finalized in consultation with the supervisor. The work has to be carried out under the supervisor and Research Report of approximately 40-50 pages has to be submitted.
- Seminar Lecture has to be delivered on research outcomes in Power Point Presentation.

CBCS CHEMISTRY

L-T-P: 3-1-0 **Credit: 4**

Unit-1: Separation Techniques

Solvent extraction: principle, distribution ratio and partition coefficient, successive extraction and separation, different methods of extraction systems, Craig extraction and counter current distribution, problems.

Chromatography: general principle, classification, mathematical relations of capacity, selectivity factor, distribution constant and retention time, chromatogram, elution in column chromatography: band broadening and column efficiency, column resolution, numerical problems, gas chromatography, high performance chromatography, thin-layer chromatography, size-exclusion chromatography, ion chromatography.

Unit-2: Electroanalytical Methods

Theory, instrumentation and applications of voltammetry, linear sweep voltammetry, anodic stripping voltammetry, cyclic voltammetry, amperometry, coulometry, electrogravimetry and polarography: electrochemical cell, reference and indicator electrodes, Ilkovic equation, half wave potential and its significance.

Unit-3: Spectroscopy

Theory, instrumentation and applications of X-rays (emission, absorption, diffraction and fluorescence methods), atomic absorption spectroscopy, atomic fluorescence spectrometry, atomic emission spectrometry, inductively coupled plasma-atomic absorption spectrometry.

Principle and applications of rotational, vibrational, Raman, electronic, NMR and mass spectroscopy.

Combined applications of different spectroscopic techniques (UV, IR, NMR, Mass) for structure elucidation.

Unit-4: Polymer

Introduction, classification, different molecular weights and their determination, polymerization techniques, controlled polymerizations, glass transition temperature, crystallinity, mechanical properties, polymer modification and manufacturing of commodity polymers.

Unit-5: Nanoscience and Nanotechnology

Introduction, importance, classifications and theoretical aspect of nanomaterials, top down-bottom up approach, different synthetic strategy of metal/metal oxide/semiconducting materials, template based synthesis, size, shape and dimension controlled synthesis, properties and size effect of nanomaterials: optoelectronic, mechanical, magnetic, and catalytic properties, applications of nanomaterials.

Different Instrumental Techniques for characterization: Basic principles and applications of X-ray diffraction, electron microscopies (SEM, TEM), scanning probe microscopies (STM), atomic force microscopy (AFM), size analysis (DLS), thermal (DSC, DTA), and XPS.

Recommended Books

1. G. D. Christian, Analytical Chemistry, 5th Edition (1994), John Wiley & Sons, New York.
2. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry - An Introduction, 7th Edition (2000), Saunders College Publishing, Philadelphia, London.
3. J. M. Hollas, Modern Spectroscopy, 4th edition (2004) John Wiley & Sons, Ltd., Chichester.
4. C. N. Banwell and E.M. Mc Cash, Fundamentals of Molecular Spectroscopy, 4th edition (1994), Tata McGraw Hill, New Delhi.
5. R. M. Silverstein and F.X. Webster, Spectroscopic Identification of Organic Compounds, 6th Edition (2003) John Wiley, New York.
6. G. Odian, Principles of Polymerization, 3rd Edition (1991), John Wiley, Singapore
7. F. W. Billmayer, Jr., Text Book of Polymer Science, 3rd Edition (1984), Willey-Interscience, NY
8. C. N. R. Rao, A. Müller, A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Vols 1 and 2, Wiley-VCH, Weinheim, 2004.
9. C. N. R. Rao, A. Muller and A. K. Cheetham, Nanomaterials Chemistry: Recent Developments and New Directions, Wiley-VCH, Weinheim, Germany, 2007.

CBCS-2 BIOSTATISTICS

L-T-P: 3-1-0 **Credit - 4**

Unit-1: Sets, Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions, Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc. Simple observations about these functions like increasing, decreasing and, periodicity. Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits.

Unit-2: Intuitive idea of algebraic relationships and convergence, Infinite Geometric Series, Series formulas for ex, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits.

Unit-3: Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above.

Unit-4: Points in plane and space and coordinate form. Examples of matrices inducing Dilation, Rotation, Reflection and System of linear equations. Examples of matrices arising in Physical, Biological Sciences and Biological networks. Sum and Produce of matrices upto order 3.

Unit-5: Measures of central tendency. Measures of dispersion; skewness, kurtosis. Elementary Probability and basic laws. Discrete and Continuous Random variable, Mathematical Expectation, Mean and Variance of Binomial, Poisson and Normal distribution. Sample mean and Sampling variance. Hypothesis testing using standard normal variate. Curve Fitting. Correlation and Regression. Emphasis on examples from Biological Sciences.

Recommended Books

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet: Introduction to Mathematics for Life Scientists,S pringer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
3. A. Edmondson and D. Druce: Advanced Biology Statistics, Oxford University Press; 1996.
4. W. Danial: Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.