



## **CHOICE BASED CREDIT SYSTEM**

# **Syllabus of M.Sc. in Applied Chemistry**

**[Effective from the Academic Session 2019-2020]**

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

<b>CREDIT DISTRIBUTION ACROSS THE COURSE</b>				
<b>COURSE TYPE</b>	<b>TOTAL PAPERS</b>	<b>CREDIT</b>		<b>CREDIT</b>
		<b>THEORY</b>	<b>PRACTICAL</b>	
CORE COURSES (CC)	16	$8 \times 4 = 32$	$7 \times 2 = 14$ $1 \times 4 = 4$	$32 + 18 = 50$
APPLIED PAPERS	4	$3 \times 4 = 12$	$1 \times 4 = 4$	$12 + 4 = 16$
ELECTIVE PAPERS	3	$3 \times 2 = 6$	0	6
CBCS	2	8	0	8
<b>Total Credit</b>				<b>80</b>
<b>NON-CGPA</b>				
AECC	8	$1 \times 8 = 8$		8
<b>Grand Total Credit</b>				<b>88</b>
<b>Abbreviations Used:</b>				
CC = CORE COURSES				
CBCS = GENERAL ELECTIVES				
AECC = ABILITY ENHANCEMENT COMPULSORY COURSES				
NON-CGPA = NON CREDIT COURSES				

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

**SEMESTER WISE CREDIT/MARKS DISTRIBUTION**

**SEMESTER I**

<b>COURSE TYPE</b>	<b>SUBJECT CODE</b>	<b>SUBJECT NAME</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CREDIT</b>	<b>CONTACT HOURS</b>	<b>MARKS DISTRIBUTION</b>
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
<b>TOTAL</b>			<b>12</b>	<b>4</b>	<b>6</b>	<b>22</b>	<b>28</b>	<b>550</b>
<b>NON-CGPA</b>								
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
<b>TOTAL</b>			<b>12</b>	<b>4</b>	<b>8</b>	<b>24</b>	<b>30</b>	<b>600</b>

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
<b>TOTAL</b>			<b>12</b>	<b>4</b>	<b>6</b>	<b>22</b>	<b>28</b>	<b>550</b>
<b>NON-CGPA</b>								
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
<b>TOTAL</b>			<b>12</b>	<b>4</b>	<b>8</b>	<b>24</b>	<b>30</b>	<b>600</b>

**SEMESTER WISE CREDIT/MARKS DISTRIBUTION**

**SEMESTER III**

<b>COURSE TYPE</b>	<b>SUBJECT CODE</b>	<b>SUBJECT NAME</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CREDIT</b>	<b>CONTACT HOURS</b>	<b>MARKS DISTRIBUTION</b>
CC 13	MCH-301	PRINCIPLES AND APPLICATIONS OF MOLECULAR SPECTROSCOPY	3	1	0	4	4	100
APPLIED 1	MCH-302A	APPLIED PAPER I : MEDICINAL CHEMISTRY I	3	1	0	4	4	100
APPLIED 2	MCH-303A	APPLIED PAPER II: ADVANCED ORGANIC SYNTHESIS	3	1	0	4	4	100
ELECTIVE 1	****	*****	2	0	0	2	2	50
APPLIED 3	MCH-391A	APPLIED PAPER III: APPLIED PRACTICAL	0	0	4	4	12	100
<b>TOTAL</b>			<b>11</b>	<b>3</b>	<b>4</b>	<b>18</b>	<b>26</b>	<b>450</b>
<b>NON-CGPA</b>								
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
<b>TOTAL</b>			<b>11</b>	<b>3</b>	<b>6</b>	<b>20</b>	<b>28</b>	<b>500</b>

**SEMESTER WISE CREDIT/MARKS DISTRIBUTION**

**SEMESTER IV**

<b>COURSE TYPE</b>	<b>SUBJECT CODE</b>	<b>SUBJECT NAME</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>CREDIT</b>	<b>CONTACT HOURS</b>	<b>MARKS DISTRIBUTION</b>
CC 14	MCH-401	SPECTROSCOPY FOR STRUCTURE ELUCIDATION	3	1	0	4	4	100
APPLIED 4	MCH-402A	APPLIED PAPER IV : MEDICINAL CHEMISTRY II	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-491A	DISSERTATION	0	0	4	4	8	100
CC 16	MCH-492A	INDUSTRIAL TRAINING	0	0	2	2	4	50
<b>TOTAL</b>			<b>10</b>	<b>2</b>	<b>6</b>	<b>18</b>	<b>24</b>	<b>450</b>
<b>NON-CGPA</b>								
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
<b>TOTAL</b>			<b>10</b>	<b>2</b>	<b>8</b>	<b>20</b>	<b>26</b>	<b>500</b>

## **SEMESTER III**

### ➤ **APPLIED PAPER I**

MCH-302A: Medicinal Chemistry I

### ➤ **APPLIED PAPER II**

MCH-303A: Advanced Organic Synthesis

### ➤ **APPLIED PAPER III**

MCH-391A: Applied Practical

### ➤ **ELECTIVE PAPER I**

MCH-304A: Applied Electrochemistry

MCH-305A: Paints Chemistry

## **SEMESTER IV**

### ➤ **APPLIED PAPER IV**

MCH-402A: Medicinal Chemistry II

### ➤ **ELECTIVE PAPER II**

MCH-403A: Polymer Chemistry

MCH-404A: Advanced Spectroscopy

### ➤ **ELECTIVE PAPER III**

MCH-405A: Materials Chemistry

MCH-406A: 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. Saunders 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-alternate 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. Stereogenicity 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  $\pi$  and  $\sigma$  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, 1st 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. Laidler, 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<sub>2</sub>SO<sub>4</sub>) 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. Shoemaker, 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  $\pi$ - systems (cyclic and non cyclic).

### Unit 3: Organometallic Chemistry

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

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 topological 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 Organometallic 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, 2<sup>nd</sup> Edition (1976), John Wiley, New York.
7. G. D. Christian, Analytical Chemistry, 5<sup>th</sup> 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, 7<sup>th</sup> Edition (2000), Saunders College Publishing, Philadelphia, London.
10. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry - An Introduction, 7<sup>th</sup> Edition (2000), Saunders College Publishing, Philadelphia, London.
11. J. H. Kennedy, Analytical Chemistry: Principles, 2<sup>nd</sup> 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, substituent constants, theories of substituent effects, interpretation of  $\sigma$ -values, reaction constant  $\rho$ , 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-Löffler-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) Baker's 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, Umpolung 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. Eller, 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-Onsager 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, 5<sup>th</sup> 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, 2<sup>nd</sup> 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<sub>3</sub>CO<sub>2</sub>H)
- Determination of the individual strengths of (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> and Na<sub>2</sub>SO<sub>4</sub> in a mixture conductometrically
- Conductometric titration of Zn(II) vs K<sub>4</sub>[Fe(CN)<sub>6</sub>] and determination of composition of the complex
- Determination of CMC of SDS conductometrically
- Potentiometric titration of mixture of acids (HCl and CH<sub>3</sub>CO<sub>2</sub>H)
- Determination of the formal redox potential of Fe<sup>2+</sup>/Fe<sup>3+</sup> system potentiometrically
- Potentiometric titration of K<sub>4</sub>[Fe(CN)<sub>6</sub>] by ZnSO<sub>4</sub> or Pb(NO<sub>3</sub>)<sub>2</sub> 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 pK<sub>in</sub> 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. Shoemaker, 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 topology, 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<sub>2</sub>, A<sub>3</sub>X and AB systems.

*FT-NMR*: Rotating frame of reference, effect of radiofrequency pulses, FID, Multi pulse operation, measurement of T<sub>1</sub> by inversion recovery method, spin echo and measurement of T<sub>2</sub>.

## Recommended Books

1. J. M. Hollas, Modern Spectroscopy, 4<sup>th</sup> edition (2004) John Wiley & Sons, Ltd., Chichester.
2. C. N. Banwell and E.M. Mc Cash, Fundamentals of Molecular Spectroscopy, 4<sup>th</sup> edition (1994), Tata McGraw Hill, New Delhi.
3. J. D. Graybeal, Molecular spectroscopy
4. I. N. Levine, Molecular spectroscopy
5. G. Herzberg, 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-302A: MEDICINAL CHEMISTRY I

L-T-P: 3-1-0

Credit: 4

### UNIT 1:

Introduction to medicinal chemistry, historical development, classification of drugs.

#### **Physicochemical properties in relation to biological action**

Ionization, solubility, partition coefficient, hydrogen bonding, protein binding, chelation, bioisosterism, optical and geometrical isomerism.

**Drug metabolism principles:** Phase I and Phase II, factors affecting drug metabolism including stereochemical aspects.

### UNIT 2:

**Antibiotics:** Introduction,  $\beta$ -lactam antibiotics, classification, SAR and chemical degradation of penicillin, cephalosporins-classification, tetracycline antibiotics-SAR, miscellaneous antibiotics. Synthesis of ampicillin, cephadrine, methacycline, chloramphenicol

**Antimycobacterials:** p-Aminosalicylic acid, Thiourea, Pyrazinamide, Cyclosporin, Dapsone, Chloramphenicol, Ethionamide and sulphoxone Na.

**Anti-Viral agents:** Introduction, viral diseases, viral replication, and transformation of cells, investigation of antiviral agents, Chemotherapy for HIV. Synthesis of Idoxuridine, acyclovir, amantadine and cytarabine.

**Anti-malarial agents:** Introduction, malarial parasite, and its life cycle, development of antimalarials, chemotherapy of malaria. Synthesis of Chloroquin, primaquine, proguanil, and Quinacrine

**Anthelmintics and antiamoebic drugs:** Introduction to Helminthiasis, Anthelmintics, drugs used in cestode infection, drugs used in trematode infection, origin of antiamoebic drug, drugs used in nematode infection. Synthesis of: Clioquinol, Iodoquinol, Haloquinol, Dichlorophen, Niclosamide.

### UNIT 3:

#### **General and Local Anesthetics**

Introduction, medicinal aspects of anesthetics, MOA classification (Cyclopropane, Thiopentane sodium)

**Inhalation Anesthetics:** Halothane, Methoxyflurane, Enflurane, Sevoflurane, Isoflurane, Desflurane

**Diuretics:** Introduction, mode of action, loop diuretics. Synthesis of Bumetanide, Furosemide, Ethacrynic acid, and clorexolone Quinethazone

**Anti-hypertensive Agents:** Timolol, Captopril, Lisinopril, Enalapril, Benazepril hydrochloride, Quinapril hydrochloride.

**Antidiabetic Agents-** Type-I and Type-II diabetes, Insulin, thiazolidinediones, Synthesis of major antidiabetic drugs

**Anti-inflammatory drugs:** Introduction, etiology of inflammatory diseases. Synthesis of: Sodium salicylate, Aspirin, Mefenamic acid, Tolmetin, Zomepirac, Diclofenac, Phenylbutazone and its derivatives, pyrazolone.

**Antipyretics:** Indomethacin, Phenylbutazone, and Analgin.

**Morphine and related drugs:** SAR of Morphine analogues, Morphine sulphate, Codeine, Meperidine hydrochloride, Anileridine hydrochloride, Diphenoxylate hydrochloride, Loperamide hydrochloride, Fentanyl citrate, Methadone hydrochloride, Propoxyphene hydrochloride, Pentazocine.

#### UNIT 4:

##### CNS Active Drugs

**Hypnotics and sedatives:** SAR of Benzodiazepines, Chlordiazepoxide, Diazepam, Oxazepam, Chlorazepate, Lorazepam, SAR of Barbiturates, Phenobarbital, Mephobarbital, Amobarbital, Butobarbital, Pentobarbital, Non-barbiturates, amides and imides, aldehydes and derivatives. **Anticonvulsants:** Epilepsy introduction, Barbiturates, Hydantoins, Oxazolidinediones, Succinimides,

**CNS-stimulants:** CNS stimulants of natural origin and synthetic CNS stimulants.

**Antipsychotics:** Phenthiazines, Triflupromazine, Thioridazine hydrochloride, Piperacetazine hydrochloride

**Antidepressants:** Tricyclic antidepressants, monoamine oxidase drugs.

**Anti-anxiety drugs:** Meprobamate and related drugs. Benzodiazepines, (Diazepam, Amitriptyline, Theophylline, Phenytoin sodium, Pentobarbitone sodium).

#### UNIT 5:

**Histamines and Antihistaminic agents:** Introduction, histamine H<sub>1</sub>-receptor antagonists. Inhibitors of histamine release. Synthesis of: alkyl amines, phenothiazines, piperazine derivatives.

**Adrenergic and cholinergic drugs:** Adrenergic hormones and drugs, storage, release and metabolism of Catecholamines (Isoprenaline, Adrenaline, salbutamol).

**Cholinergic and anticholinesterases:** storage, release and metabolism of acetylcholine (Methocholine chloride).

#### Recommended Books

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, 8th edition, edited by R.F. Doerge, J.B. Lippincott Company, Philadelphia, 1982.
2. Pharmaceutical Chemicals in Perspective, B.G. Reuben and H.A. Wittcoff, John Wiley & Sons, New York, 1989.
3. W.C. Foye, Principles of Medicinal Chemistry, Lea & Febiger, Philadelphia, USA.
4. The Organic Chemistry of Drug Design and Drug Action, by R. B. Silverman, Academic Press, 1992.
5. Drug Designs - A series of monographs in medicinal chemistry edited by A. J. Ariens. 1st edition, Vol. I, II, V, VIII & IX (only relevant chapters).
6. Reuben, B.G.; Wittcoff, H.A. Pharmaceutical Chemicals in Perspective, John Wiley & Sons, New York, 1989.
7. An introduction to Medicinal chemistry, G. L. Patrick, Oxford Press
8. Burger's Medicinal Chemistry and Drug Discovery, Vol. 1-5, Wiley
9. Medicinal Chemistry, Ashutoshkar, New Age International Ltd
10. Principles of Medicinal Chemistry, W. O. Foye, Varghese Pub. House
11. Essentials of Medical Pharmacology, K. D. Tripathi, Jaypee Brothers
12. A text book of medicinal chemistry, P. Primo, CBS Publishers & Distributors
13. Text book of pharmaceutical organic chemistry, Md. Ali, CBS Publishers
14. A Text book of pharmaceutical chemistry, Jayasree Ghosh
15. The organic chemistry of drug design and drug action, Silverman R. Academic Press.
16. Medicinal Chemistry by Burger, Vol I – VI.

17. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, 12th Edition, Lippincott Williams & Wilkins, Wolters Kluwer (India) Pvt. Ltd, New Delhi.
18. Comprehensive Medicinal Chemistry – Corwin and Hansch.
19. Computational and structural approaches to drug design edited by Robert M Stroud and Janet. F Moore
20. Introduction to Quantitative Drug Design by Y.C. Martin.
21. Principles of Medicinal Chemistry by William Foye, 7th Edition, Lippincott Williams & Wilkins, Wolters Kluwer (India) Pvt.Ltd, New Delhi.
22. Drug Design Volumes by Arienes, Academic Press, Elsevier Publishers, Noida, Uttar Pradesh.
23. Principles of Drug Design by Smith.
24. The Organic Chemistry of the Drug Design and Drug action by Richard
25. B.Silverman, II Edition, Elsevier Publishers, New Delhi.
26. An Introduction to Medicinal Chemistry, Graham L.Patrick, III Edition, Oxford University Press, USA.
27. Biopharmaceutics and pharmacokinetics, DM.Brahmankar, Sunil B.Jaiswal II Edition, 2014, VallabhPrakashan, New Delhi.
28. Peptidomimetics in Organic and Medicinal Chemistry by Antonio Guarna and Andrea Trabocchi, First edition, Wiley publishers.
29. Wilson and Gisvold's Organic medicinal and Pharmaceutical Chemistry.
30. Foye's Principles of Medicinal Chemistry.
31. Burger's Medicinal Chemistry, Vol I to IV.
32. The Organic Chemistry of Drug Synthesis by Lednicher, Vol. 1-5.
33. Text book of practical organic chemistry- A.I.Vogel.

## MCH-303A: ADVANCED ORGANIC SYNTHESIS

L-T-P: 3-1-0

Credit: 4

### Unit-1: Radical Reactions, Protection and Deprotection 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. The role of protective groups in organic synthesis, principle of protection and deprotection, Different procedure for protection and deprotection of hydroxyl, phenols, amines, carbonyls and carboxylic groups.

### Unit-2: 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<sub>2</sub>O and CO<sub>2</sub> as solvents, etc. concept of organocatalyst, Green Chemistry in real world cases and planning green synthesis in chemical laboratory.

### Unit-3: 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 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-4: Organometallic Chemistry

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

### Unit-5: 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, coumarins and chromones; heterocycles in pharmaceutical industry.

## Unit 6: Catalysis –Principles and Applications

Basic principles of catalysis: adsorption isotherms, surface area pore size and acid strength measurement. Enthalpy and entropy of adsorption: interpretation of chemisorptions based on the structure and the nature of the solid – solid state theories – role of defects in catalysis. Selection, preparation and evaluation of catalysts – test reaction, promoters, carriers and stabilizers. Mechanisms of selected reactions: hydrogenation and dehydrogenation reaction – dehydration of alcohols, olefin hydrogenation, decomposition of nitrous oxide, oxidation of CO, ketonization of carboxylic acids, cracking of hydrocarbons.

Applications: petrochemical industry – reforming and refining – value added chemicals- environmental protection auto exhaust catalysts Novel catalytic material clusters, zeolites, mesoporous materials. Electrocatalysis and Photo catalysis.

### 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)
9. 3. Peter Sykes, A Guide book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman Ltd., New Delhi.
10. 4. S. M. Mukherjee and S.P. Singh, Reaction Mechanism in Organic Chemistry, Ist Edition (1990), Macmillan India Ltd., New Delhi.
11. 5. F.A. Carey and R.J. Sundburg,, Advanced Organic Chemistry, Part-A
12. F.A. Carey and R.J. Sundburg, Advanced Organic Chemistry, Part-B



## ELECTIVE 1

### MCH-304A: APPLIED ELECTROCHEMISTRY

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

**Credit: 2**

#### **Unit 1: Electrochemical Storage Cell**

Fundamentals and classification of batteries, primary battery (Laclanche-dry cell and Alkaline cell), secondary battery (acid and alkaline), reserve battery, construction, working and application of acid storage batteries, lithium-MnO<sub>2</sub> batteries, nickel- metal hydride batteries, and lithium based conducting polymer battery.

**Fuel cell:** Introduction, characteristics of fuel cell, classification, construction and working principle of: gaseous fuel cells, solid oxide fuel cells, cool fuel cells, phosphoric acid fuel cell, molten carbonate fuel cell, proton exchange membrane fuel cell, problems with fuel cells.

#### **Unit 2: Bio-electrochemistry and Sensors**

Introduction, membrane potential, theoretical and modern approach of biochemical cells, electrical conduction in biological organism, electrochemical communication in biological organisms.

**Biosensors:** Introduction, electrochemical bio-sensors- characteristics, use as a transducer, types. **Ion-Sensors:** Introduction, types, analytical and biological applications of sensors.

#### **Unit 3: Industrial Electrochemistry**

Fundamentals, electro- organic synthesis (Kolbes synthesis, oxidation and reduction of hydrocarbons, reduction of nitro-compounds), electro inorganic synthesis of fluorine and ozone, synthesis of metal salts via anodic dissolution.

The chloro-alkalyl industry: Introduction, general concepts of brine electrolysis, modern technological developments (electrode materials, membrane), chlorine cell technologies (diaphragm cells, membrane cell).

Electrochemistry applied to electrodeposition, electroplating, electroplating of metals chromium, cadmium, nickel, copper, silver, gold, purpose of metal electroplating composition and condition of plating bath, applications waste treatment and metal recovery.

#### **Unit 4: Corrosion**

Definition, scope and economics of corrosion, factors affecting corrosion, theories of corrosion, kinetics of corrosion, Evan's diagram, Pourbaix diagram, electrochemical series, galvanic series, dry and wet corrosion, different types of corrosion-pit, soil, chemical and electrochemical, inter-granular, waterline, microbial corrosion, measurement of corrosion by different methods, passivity and its breakdown, protection against corrosion: design and material selection, modification of materials, corrosion inhibitors, protective coatings, cathodic and anodic protection.

Corrosion testing techniques: XRD, ESCA, FTIR and surface techniques, corrosion in industries with special reference to oil and mining industries.

#### **Recommended Books:**

1. Modern Electrochemistry, 2nd Ed. Vol.1,2A &2B, Bockris & Reddy (Plenum, NY) 1998
2. Chemical & Electrochemical Energy Systems, R. Narayan & B. Viswanathan (University Press), 1998.
3. Industrial Electrochemistry, D. Peltcher & F. C. Walsh (Chapman & Hall) 1990.
4. Biosensors-theory and Applications, Donald G. Burek, (Technomic), 1993.
5. Principles and Applications of Electrochemistry–Crow (Chapman hall, New York) 2014
6. Fundamentals of Electrochemistry, Fulkner and A. J. Bard, Wiley India, 2006.

## MCH305A: PAINTS CHEMISTRY

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

**Credit: 2**

### Unit 1: Fundamentals

Colloidal chemistry of coatings, surface chemistry of pigments, pigment dispersion and wetting, flushing of pigments, effect of pigment volume concentration on paint properties.

Paint additives, solvents, basics of paint formulations, machinery for grinding of pigments and extenders.

### Unit 2: Insulating and Intumescent Coatings

Preparation of different solvent & water based coatings, powder coatings, dry distempers, oil based distempers and paints, PU based clear coats/ dispersions, washable distempers, application of these coatings, cement paints, other stiff paints, putties, manufacturing of alkyds, emulsions, paints, filtration of resins, ultra filtration of ED resins, forming of hard resins, various insulating resins and polymers used for heat and electrical insulations.

### Unit 3: Advanced Paints Technology

Paint industry overview, problems and prospects, formulation of primers, zinc rich epoxy, micaceous iron oxide, zinc chromate and tetraoxy chromate, zinc phosphate based primers, wash primers, anti fouling coatings, paints for marine environments, vinyl paints, road marking paints, cement paints, automotive protection products, paints, finishing and refinishing, coatings for high temperature, aerospace and aircrafts, insulating paints, UV-curable coatings, electrodeposition coatings, metallic paints.

### References

1. Paint and Surface Coatings by Lambourne and Strivens
2. Organic Coatings Science and Technology by Zeno Wicks et al
3. Surface Coatings Science and Technology by Swaraj Paul
4. Introduction to Paint Chemistry by Turner
5. Pigment Hand Book Part 1, 2, 3 by Patton
6. Encyclopedic Hand book of Emulsions Technology by Sjoblom
7. Application properties of Pigments by A. Karnik
8. Paint Film Defects by Hess
9. Industrial Organic Pigments by W. Herbst

## MCH-391A: APPLIED CHEMISTRY LAB

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

**Credit: 6**

- 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 characterisation.
- Quantitative Estimation of: (a) Sugars (Glucose, Cane sugar), (b) Phenol, (c) Aniline, (d) Nitrogen by Kjeldahl method.
- Multistep drugs/dyes synthesis, their purification, characterization and comparison with theoretical data.
- Hand on experience to run different analytical instruments such as, HPLC, GC etc.

# 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  $\alpha,\beta$ -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  $^1\text{H}$  NMR,  $^{13}\text{C}$  NMR, DEPT, two dimensional NMR: COSY, NOESY.

NMR spectra of paramagnetic coordination compounds, dipolar and contact shifts,  $^{11}\text{B}$ ,  $^{19}\text{F}$ ,  $^{27}\text{Al}$ , and  $^{31}\text{P}$  – 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, 6<sup>th</sup> Edition (2003) John Wiley, New York.
2. D. H. Williams and I.F. Fleming, Spectroscopic Methods in Organic Chemistry, 4<sup>th</sup> Edition (1988), Tata-McGraw Hill, New Delhi.
3. P. Y Bruice, Organic Chemistry, 2<sup>nd</sup> Edition (1998) Prentice-Hall, New Delhi.
4. E. A. V. Ebsworth, D. W. H. Rankin and S. Cradock, Structural Methods in Inorganic Chemistry, 1<sup>st</sup> 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, 1<sup>st</sup> Edition (1971), Affiliated East-West Press, New Delhi.

## MCH-402A: MEDICINAL CHEMISTRY II

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

**Credit: 4**

### **Unit-1: Basic concepts in Medicinal Chemistry**

Definition of Drug (WHO), Stereo chemical aspects of drugs, Classification of drugs based on chemical structure, pharmacological action and mechanisms at molecular level. Mechanism of drug action-Physical and Chemical action. Explanation of Quantal dose, Graded dose, Efficacy, Potency, LD<sub>50</sub>, ED<sub>50</sub> Therapeutic index and Margin of safety. Targets of Drug action: a) Receptors: Concept, Types of receptors, Agonist, Antagonist, Partial and Inverse agonist. b) Ion channels c) Enzyme: Specific and nonspecific Enzymes d) Carrier molecules.

### **Unit-2: Pharmacodynamic Agents**

Definition, Mechanism of action at molecular level, synthesis, Medicinal uses and Adverse effects of the following classes of compounds with special reference to specific drugs mentioned under each class. 1) Anti-Inflammatory – Ibuprofen and NSAIDs. 2) Anti-Emetic- Metoclopramide (5-HT<sub>2</sub>-receptor antagonist). 3) Anti-Histamines – Pheniramine and H<sub>1</sub>-Antagonist 4) Anti-Ulcer – Ranitidine, H<sub>2</sub>-Antagonist Omeprazole-H<sup>+</sup>K<sup>+</sup> ATPase inhibitor. 5) Anti-Hypertensives: a)  $\alpha$ -Blocker- Propranolol b)  $\beta$ -Blocker- Atenolol c) Ca<sup>2+</sup> channel blockers- Nifedipine d) ACE-inhibitor - Enalapril e) Centrally active - Methyl Dopa. 6) Anti-Anginal Drugs- Isosorbide dinitrate 7) Bronchodilator- Salbutamol. 8) Anti-Depressants- Fluoxetine. 9). Drugs used in Schizophrenia - Chlorpromazine 10) Anxiolytic-Sedative - Diazepam.

### **Unit-3: Chemotherapeutic Agents**

Introduction to Chemotherapy, differences between Pharmacodynamic agents and chemotherapeutic agents. 1) Inhibition of cell wall biosynthesis: structures of Methicillin, Ampicillin, Amoxicillin, Carbenicillin and Cloxacillin. Synthesis of Phenoxy Methyl Penicillin and Cephalosporin. New  $\beta$ -Lactam Drugs -structures of Imipenem and Nocardicin. Mechanism of Inhibition of cell wall biosynthesis by  $\beta$ -Lactam antibiotics 2) Inhibitors of protein biosynthesis: Structures of Streptomycin, Gentamycin-A, Tetracycline, Oxy-tetracycline, Doxycycline, Chlorotetracycline, Erythromycin and synthesis of Chloramphenicol. 3) Inhibition of RNA synthesis: Mechanism of action, Structure and uses of Rifampicin. 4) Inhibition of DNA synthesis: Mechanism of action, Structures and uses of Norfloxacin, Ofloxacin, Nalidixic acid, Synthesis of Ciprofloxacin. 5) Inhibition of DNA by polymerase: Mechanism of action, uses and synthesis of AZT. Bacterial resistance to chemotherapeutic agents.

### **Unit 4: Drugs acting on Endocrine system**

Nomenclature, Stereochemistry and metabolism of steroids.

**Sex hormones:** Testosterone, Nandrolone, Progesterone, Oestrone, Oestradiol, Oestrone, Diethyl stilbestrol.

**Drugs for erectile dysfunction:** Sildenafil, Tadalafil.

**Oral contraceptives:** Mifepristone, Norgestrel, Levonorgestrel.

**Corticosteroids:** Cortisone, Hydrocortisone, Prednisolone, Betamethasone, Dexamethasone.

**Thyroid and antithyroid drugs:** L-Thyroxine, L-Thyronine, Propylthiouracil, Methimazole.

### Unit-5:

**Anti-arrhythmic Drugs:** Quinidine sulphate, Procainamide hydrochloride, Phenytoin sodium, Lidocaine hydrochloride, Tocainide hydrochloride, Mexiletine hydrochloride, Lorcainide hydrochloride, Amiodarone, Sotalol.

**Anti-hyperlipidemic agents:** Clofibrate, Lovastatin, Cholesteramine and Cholestipol.

**Coagulant & Anticoagulants:** Introduction, factors affecting coagulant and anti-coagulant. Mechanism of Blood coagulation and Anticoagulation. Structure of Vitamin K1, Vitamin K2 and heparin. Synthesis of Coumarins and indanediones, Menadione, Acetomenadione, Anisindione, clopidogrel

**Drugs used in Congestive Heart Failure:** Digoxin, Digitoxin, Nesiritide, Bosentan, Tezosentan

### UNIT – 6

#### Introduction to Drug Design

Various approaches used in drug design. Development of new drugs, factors affecting development of new drugs, sources of lead compounds, serendipity and drug development. Concept of QSAR, Physicochemical parameters used in quantitative structure activity relationship (QSAR) such as partition coefficient, Hammett's electronic parameter, Taft's steric parameter and Hansch analysis.

Pharmacophore modeling and docking techniques.

**Combinatorial Chemistry:** Concept and applications chemistry: solid phase and solution phase synthesis.

#### Recommended Books

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceuticals Chemistry, 8th edition, edited by R.F. Doerge, J.B. Lippincott Company, Philadelphia, 1982.
2. Pharmaceutical Chemicals in Perspective, B.G. Reuben and H.A. Wittcoff, John Wiley & Sons, New York, 1989.
3. W.C. Foye, Principles of Medicinal Chemistry, Lea & Febiger, Philadelphia, USA.
4. The Organic Chemistry of Drug Design and Drug Action, by R. B. Silverman, Academic Press, 1992.
5. Drug Designs - A series of monographs in medicinal chemistry edited by A. J. Ariens. 1st edition, Vol. I, II, V, VIII & IX (only relevant chapters).
6. Reuben, B.G.; Wittcoff, H.A. Pharmaceutical Chemicals in Perspective, John Wiley & Sons, New York, 1989.
7. An introduction to Medicinal chemistry, G. L. Patrick, Oxford Press
8. Burger's Medicinal Chemistry and Drug Discovery, Vol. 1-5, Wiley
9. Medicinal Chemistry, Ashutoshkar, New Age International Ltd
10. Principles of Medicinal Chemistry, W. O. Foye, Varghese Pub. House
11. Essentials of Medical Pharmacology, K. D. Tripathi, Jaypee Brothers
12. A text book of medicinal chemistry, P. Primo, CBS Publishers & Distributors
13. Text book of pharmaceutical organic chemistry, Md. Ali, CBS Publishers
14. A Text book of pharmaceutical chemistry, Jayasree Ghosh
15. The organic chemistry of drug design and drug action, Silvermann R. Academic press.
16. Medicinal Chemistry by Burger, Vol I – VI.

17. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, 12th Edition, Lippincott Williams & Wilkins, Wolters Kluwer (India) Pvt. Ltd, New Delhi.
18. Comprehensive Medicinal Chemistry – Corwin and Hansch.
19. Computational and structural approaches to drug design edited by Robert M Stroud and Janet. F Moore
20. Introduction to Quantitative Drug Design by Y.C. Martin.
21. Principles of Medicinal Chemistry by William Foye, 7th Edition, Lippincott Williams & Wilkins, Wolters Kluwer (India) Pvt. Ltd, New Delhi.
22. Drug Design Volumes by Arienes, Academic Press, Elsevier Publishers, Noida, Uttar Pradesh.
23. Principles of Drug Design by Smith.
24. The Organic Chemistry of the Drug Design and Drug action by Richard
25. B. Silverman, II Edition, Elsevier Publishers, New Delhi.
26. An Introduction to Medicinal Chemistry, Graham L. Patrick, III Edition, Oxford University Press, USA.
27. Biopharmaceutics and pharmacokinetics, DM. Brahmankar, Sunil B. Jaiswal II Edition, 2014, Vallabh Prakashan, New Delhi.
28. Peptidomimetics in Organic and Medicinal Chemistry by Antonio Guarna and Andrea Trabocchi, First edition, Wiley publishers.
29. Wilson and Gisvold's Organic medicinal and Pharmaceutical Chemistry.
30. Foye's Principles of Medicinal Chemistry.
31. Burger's Medicinal Chemistry, Vol I to IV.
32. The Organic Chemistry of Drug Synthesis by Lednicher, Vol. 1-5.
33. Text book of practical organic chemistry- A.I. Vogel.

## ELECTIVE-II

### MCH-403A: 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, coordination 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, two dimensional polymer, hybrid materials based on polymers and any advanced polymeric topics.

#### **Recommended Books**

1. G. Odian, Principles of Polymerization, 3<sup>rd</sup> Edition (1991), John Wiley, Singapore
2. F. W. Billmeyer, Jr., Text Book of Polymer Science, 3<sup>rd</sup> Edition (1984), Wiley-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, 8<sup>th</sup> Edition, Oxford University Press, New York
7. P. J. Flory, Polymer Chemistry



## MCH-404A: 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. Aruldas, 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-405A: 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, Stober synthesis of silica, Micro and mesoporous silica synthesis, composite nanostructures, carbon based nanomaterials such as carbon nanotube, fullerene, graphene, quantum dots, 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. Bréchnignac, 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-406A: 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 their 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- RbAg<sub>4</sub>I<sub>5</sub>, Arrhenius 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 potassium fertilizer, mixture of potassium, potassium sulphate, mixed fertilizer.

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

### **Unit 3: Glass and Ceramic Industry**

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<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, Cl<sub>2</sub> & acetylene gases. Liquefaction of gases, production of low temperature.

Inorganic fine chemicals, magnesia, alumina, AlCl<sub>3</sub>, calcium carbonate, sodium silicate, MnO<sub>2</sub>, FeSO<sub>4</sub>, PbO<sub>2</sub> 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 Transducers, 2nd Edn, Prentice, Hall of India (2003).
9. Rajankumar Basak, Fertilizers, A text Book

### **MCH-491A: DISSERTATION**

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

**Credit: 4**

- 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

### **MCH-492A: INDUSTRIAL TRAINING**

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

**Credit: 2**

- Industrial training should be arranged for at least two weeks
- Industrial report should be documented
- Seminar lecture has to be delivered on industrial experience 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. Billmeyer, Jr., Text Book of Polymer Science, 3rd Edition (1984), Wiley-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  $e^x$ ,  $\log(1+x)$ ,  $\sin x$ ,  $\cos x$ . 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 Product 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, Springer 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.