

**COOCH BEHAR PANCHANAN BARMA UNIVERSITY**  
Syllabus for Post Graduate Course in Chemistry ( For the session 2020 –2021 )

**SYLLABUS for M.Sc in CHEMISTRY**

**(Course Duration : Four Semester – Two Year)**

**Total Credit : 80**

**Credit per Semester : 20**

**Total Marks = 1600**

**Theory = 700:**

**Practical = 300**

**Cont. Evaluation = 320**

**Viva/Seminar/Project = 200**

**Attendance = 80**

## Course Structure

Se m	Paper Code	Paper Name	Theo	CE	Attend	Total	Credit	Pract	Viva/ Seminar/ Project	Credit	Total Marks	Total Credit
Semester - 1	Core-1	Organic Chemistry-1	50	20	5	75	3	25		2	100	5
	Core-2	Inorganic Chemistry-1	50	20	5	75	3	25		2	100	5
	Core-3	Physical Chemistry-1	50	20	5	75	3	25		2	100	5
	Core-4	Spectroscopy	50	20	5	75	4	25		1	100	5
Semester - 2	Core-5	Organic Chemistry-2	50	20	5	75	3	25		2	100	5
	Core-6	Inorganic Chemistry-2	50	20	5	75	3	25		2	100	5
	Core-7	Physical Chemistry-2	50	20	5	75	3	25		2	100	5
	Core-8	Advanced Spectroscopy	50	20	5	75	4	25		1	100	5
Semester - 3	Core-9	Org/Inorg	50	20	5	75			25		100	5
	DCE-I	Special paper [one from pool of three]	50	20	5	75			25		100	5
	DCE-II	Special paper (practical) [one from pool of three]		20	5			50	25	5	100	5
	GE-1	one from pool of three	50	20	5	75	3		25	2	100	5
Semester - 4	Core-10	Physical Analytical & Industrial	50	20	5	75			25		100	5
	DCE-III	Special paper [one from pool of three]	50	20	5	75			25		100	5
	DCE-IV	Special paper (practical) [one from pool of three]		20	5			50	25		100	5
	GE-2	one from pool of three	50	20	5	75	3		25	2	100	5
											1600	80

## Course Content

### Semester – I

#### Organic Chemistry

Paper Name : Organic Chemistry – I, Credit-5, FM-100

Paper Code : Core-1T

Theory (T) : Credit – 3, Full Marks – 75 (ESE -50 + CE- 20 + Attendance-5)

#### A. Structure Activity Relationship (12 Lectures)

MO treatment of acyclic and cyclic conjugated systems; Hückel's rule and concept of aromaticity, annulenes, heteroannulenes, fullerenes ( $C_{60}$ ), alternate and non-alternate hydrocarbons, anti-aromaticity, pseudo-aromaticity, homo-aromaticity; graphical methods – Frost diagram, Hückel treatment - applications to ethylene, allyl cyclopropenyl, butadiene, cyclobutadiene.

#### B. Stereochemistry (18 lectures)

Acyclic systems up to 4 chiral centers : Compounds with asymmetric carbons in branched chains, symmetry; point groups, correlation of axial dissymmetry and centrodissymmetry, Nomenclature of compounds involving axial and planar chirality, Winstein-Holness equation, Curtin Hammett principle; Conformational analysis of cyclohexene, decalins and their derivatives; Effects of conformation on reactivity in acyclic compounds and cyclohexanes. Elements of Symmetry and Chirality, Optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis.

Criteria for Chirality. Desymmetrization. Axial, planar and helical chirality: Configurational nomenclature: Axially chiral allenes, spiranes, alkyldiene cycloalkanes, chiral biaryls, atropisomerism. Planar chiral ansacomounds and trans- cyclooctene. Helically chiral compounds

Relative and absolute configuration: Determination of absolute configuration by chemical correlation methods. Racemisation, racemates and resolution techniques: Resolutions by direct crystallization, diastereoisomer salt formation chiral chromatography and asymmetric transformation. Determination of configuration in E,Z-isomers: Spectral and Chemical methods of configuration determination of E,Z isomers. Determination of configuration in aldoximes and ketoximes

#### C. Substitution & Elimination Reaction: (8 lectures)

**substitution** (aliphatic electrophilic & nucleophilic) & **Elimination reactions** of aliphatic and aromatic compounds

#### D. Pericyclic Reaction (12 lectures)

Classification and stereochemical modes. Thermal and photopericyclic reactions, Selection rules and stereochemistry of electrocyclic reactions, cycloadditions, sigmatropic rearrangements, carbene addition, cheletropic reactions. Rationalization based on Frontier M.O. approach, correlation diagrams, Dewar-Zimmermann approach, Mobius and Hückel systems, Sommelet-Hauser, Cope, aza Cope and Claisen rearrangements, Ene Reaction, Wittig rearrangement, suitable examples of  $[(2\pi + 2\pi)$ ,  $(4\pi + 2\pi)$ ,  $(4\pi + 4\pi)$ ,  $(2\pi + 2\pi + 2\pi)$ ] and metal catalyzed cycloaddition reactions.

**Paper Name : Organic Chemistry– I**

**Paper Code : Core-1P**

**Practical (P) :**

**Credit – 2,**

**Full Marks – 25**

**Practical**

**(30 practical classes)**

**Isolation of Natural products (Any three)**

1. Extraction of curcumin from turmeric.
2. Extraction of caffeine from tea/coffe.
3. Extraction of cinnamaldehyde from cinnamom
4. Extraction of Eugenol from clove
5. Extraction of Lycopene from tomatoes

**One stage preparations and Recrystallisation (any Ten)**

1. Benzilic acid rearrangement: Benzilic acid from benzil
2. Sandmeyer reaction: p-Nitroiodobenzene from p-nitroaniline
3. Heterocyclic compound: 7-Hydroxy-4-methylcoumarin from resorcinol
4. Acetylation: Mannitol hexaacetate from mannitol  
Acetanilide from Aniline.  
Glucose pentacetate from glucose
5. Claisen-Schmidt reaction Dibenzalacetone from benzaldehyde
6. Oxidation: Fluorenone from fluorine  
Benzoic acid from Benzaldehyde
7. Acetylation: Acetylferrocene from ferrocene
8. Hydrolysis: Benzoic acid from Benzamide.
9. Bromination: p-Bromoacetanilide from Acetanilide.
10. Nitration: m-dinitrobenzene from Nitrobenzene.  
p-nitroacetanilide from acetanilide
11. Benzoylation: Benzanilide from Aniline.

**Suggested Books**

- Adam Jacobs, Understanding organic reaction mechanism. Cambridge University press (1997)
- F.A. Carey and R. J. Sundberg (Part A and B) Kluwer Academic / Plenum Publishers (2000)
- E.L.Eliel, Stereochemistry of carbon compounds. John Wiley (1997)
- Modern Organic Synthesis-an introduction by George S.Zweifel and Michael H. Nantz, W. H. Freeman & company, New York
- Some Modern Methods of Organic Synthesis W. Carothers, Third Edition, Cambridge University Press, Cambridge, 1988.
- Advanced Organic Synthesis, Part B-Reactions and Synthesis, Francis A. Carey and Richard J. Sudenburg, Fourt edition, Kluwer academic publishers, New York.
- Photochemistry and Pericyclic Reactions by Jagdamba Singh
- Organic Reactions and Orbital Symmetry by Gilchrist and Storr

## Inorganic Chemistry

Paper Name : Inorganic Chemistry – I, Credit-5, FM-100

Paper Code : Core-2T

Theory (T) : Credit – 3, Full Marks – 75 (ESE -50 + CE- 20 + Attendance-5)

- A. Coordination Chemistry:** (18 lectures)  
Adjusted CFT, Effect of crystal field stabilization on ionic radii, lattice energy, hydration enthalpy and stabilization of complexes (Irving Williams order). Site preference in mixed metal oxides (Spinel and inverse spinel structures). Tetrahedral distortion and Jahn Teller effect, Static and Dynamic Jahn-Teller effect. Microstates, Russell-sander's terms, energy ordering of terms and Racah parameters, interelectronic repulsion parameters in complex ion terms-vs-free ion terms, hole formalism, determination of ground and excited state terms of  $d^n$  ions, spin-orbit coupling, effect of crystal field on Russell- Sander's terms, concept of correlation diagram.
- B. Structure & Bonding of Inorganic molecule** (10 lectures)  
Bonding in homonuclear and heteronuclear diatomic molecules of 2nd period. Bonding in triatomic ( $H_3^+$ ,  $BeH_2$ ,  $H_2O$ ), tetra-atomic ( $BH_3$ ,  $NH_3$ ) and  $CH_4$ . MO diagrams, Walsh diagrams. Models of structure prediction
- C. Reaction Mechanism-I:** (12 lectures)  
Inert and labile complexes, consideration of octahedral substitution reactions in the light of VBT and CFT. Mechanism of substitution reactions, Classification of reactions of complex compounds, energy profile diagram of ligand substitution reactions- associative (A), dissociative (D), interchange (I) etc. type pathways, relation between intimate and stoichiometric mechanisms of ligand substitution
- D. Clusters-I** (8 lectures)  
Higher boranes, carboranes, metalloboranes and metallocarboranes.

Paper Name : Inorganic Chemistry– I

Paper Code : Core-2P

Practical (P) :

Credit – 2,

Full Marks – 25

Practical

(30 practical classes)

Inorganic qualitative analysis: Less common metals – Be, Mo, W, Ti, Zr, Th, V, U, Ce and all the radicals included in the B. Sc (Honours) Chemistry syllabus.

### Suggested Books

- Ligand field theory and its application by B. N. Figgis
- Inorganic chemistry, principal of structure and reactivity by J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi
- Inorganic Chemistry, 4th edition by C. E. Housecroft, A. G. Sharpe
- Inorganic Chemistry by Shriver and Atkins
- Inorganic Chemistry, Vol.- 5 by A. K. Das, M. Das
- Elements of magnetochemistry by R. L. Dutta, A. Shyamal
- Chemistry of elements by N. N. Greenwood and A. Earnshaw
- Inorganic Chemistry: Principles , D. Banerjee
- Hand book of Inorganic analysis, G. N. Mukherjee
- Vogel's Quantitative Inorganic analysis, G. Svehla& B. Shivasankar

## Physical Chemistry

Paper Name : Physical Chemistry – I, Credit-5, FM-100

Paper Code : Core-3T

Theory (T) : Credit – 3, Full Marks – 75 (ESE -50 + CE- 20 + Attendance-5)

### A. Quantum Chemistry – I

(18 Lectures)

Schrödinger equation, Basic postulates and theorems, Physical interpretation of wave function, stationary states, operator formation, atomic unit system, Heisenberg's equation of motion, Particle in a box problem, Finite barrier problem and tunneling, Linear harmonic oscillator, Ladder operators, Angular momentum problem, Rigid rotor. Hydrogen atom problem and its implications

### B. Classical Thermodynamics

(10 Lectures)

Brief review of 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> laws of thermodynamics, Nernst heat theorem and the third law of thermodynamics, calculation of entropy changes in chemical reactions. Mathematical and thermodynamic probability, Entropy and probability, the free energy of a mixture, Partial molal quantities, Analytical form of the chemical potential in ideal solutions, Chemical potential of a solute in a binary solution, Application of Gibbs Duhem equation, Nonideal solutions, concept of activity: experimental determination of activity coefficients of non electrolytes, Application of thermodynamics to micelles and microemulsion

### C. Chemical Kinetics – I

(10 Lectures)

Potential energy surface: reaction coordinates and reaction paths, Transition state theory and thermodynamics, Reactions in solutions: enzyme catalysis and enzyme inhibition reactions, ionic reactions, oscillating reaction.

Fast reactions: Flow and stop-flow technique, Flash photolysis, Relaxation and Nuclear magnetic resonance techniques

### D. Macromolecules

(10 Lectures)

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

Paper Name : Physical Chemistry– I

Paper Code : Core-3P

Practical (P) :

Credit – 2,

Full Marks – 25

Practical

(32 practical classes)

1. Studies on the kinetics of iodination of acetone.
2. Determination of solubility product of  $PbI_2$  by titrametric method.
3. Determination of coordination number of  $Cu^{++}$  (partition method).
4. Ion exchange capacity of resin.
5. Verification of Beer's law and studies on the kinetics of alkaline hydrolysis of crystal violet.
6. Conductometric titration of a mixture of acids.
7. Estimation of acid potentiometrically.
8. Estimation of acid pH metrically.

### Suggested Books

- Quantum Chemistry by A B Sannigrahi
- Chemical Kinetics (3<sup>rd</sup> edition) Pearson Publisher by K. J. Laidler
- Polymer Science (3<sup>rd</sup> Edition) by V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar

- A Textbook of Physical Chemistry, Vol 5, by K. L. Kapoor, McGraw Hill Publisher
- Introductory polymer chemistry, by G. S. Misra
- Text Book of Polymer Science, F.W. Billmeyer
- Chemical Thermodynamics (Classical, Statistical & Irreversible) by Hrishikesh Chatterjee
- Thermodynamics For Chemists by Samuel Glasstone
- Practical Physical Chemistry by Renu Gupta (New Age International Publisher)
- An Advanced Course in Practical Chemistry by A.K. Nad, B. Mahapatra, A. Ghoshal

## Spectroscopy

**Paper Name : Spectroscopy, Credit-5, FM-100**

**Paper Code : Core-4T**

**Theory (T) : Credit – 4, Full Marks – 75 (ESE -50 + CE- 20 + Attendance-5)**

- A. Introduction to basic principles, Widths and Intensities of spectral transitions, Fourier transform, computer averaging techniques, LASERS. **(10 lectures)**
- B. **Microwave Spectroscopy:** **(10 lectures)**  
 Classifications of molecules based on moments of inertia, Rotational spectra, Rigid and non rigid rotor model, Selection rules, Spectral intensity, degeneracy and relative population of energy levels, Isotopic substitution. Symmetric top molecules
- C. **Infra-red Spectroscopy:** **(10 lectures)**  
 Vibrational and rotation-vibrational spectra, Simple harmonic oscillator model, Selection rules, Fundamentals and overtones, Hot bands, Q, P, and R branches, Chemical analysis by IR techniques
- D. **Raman Spectroscopy** **(12 lectures)**  
 Rayleigh and Raman scattering, Classical and Quantum theory of Raman effect, Stokes and anti-Stokes lines, rotational and vibrational Raman spectra, Mutual exclusion rule, Applications of Raman spectroscopy.
- E. **<sup>1</sup>H NMR.** **(20 lectures)**  
 Principle, instrumentation and different techniques (CW & FT) of NMR spectroscopy, factors influencing chemical shift, spin-spin interactions, coupling constant (J), spin decoupling, spin tickling, classification of ABX, AMX, ABC, A<sub>2</sub>B<sub>2</sub> in proton NMR.

**Paper Name : Spectroscopy**

**Paper Code : Core-4P**

**Practical (P) :**

**Credit – 1,**

**Full Marks – 25**

**Practical**

**(15 practical classes)**

IR Spectra of prepared organic and inorganic compounds/IR band assignment.

[Curcumin, caffeine of tea/coffee, cinnamaldehyde, Eugenol, Lycopene. Cobalt acetylacetonate, cis and trans [Co(en)<sub>2</sub>Cl<sub>2</sub>], Co(salen), Cu(acac)<sub>2</sub>.H<sub>2</sub>O]

### Suggested Books

- Organic Spectroscopy: Dyer & Silverstein
- Fundamentals of Molecular Spectroscopy : C. N. Banwell
- Fundamentals of photochemistry : K. K. Rohatgi-Mukherjee
- Introduction to Molecular spectroscopy: G M Barrow

## Semester – II

### Organic Chemistry

Paper Name : Organic Chemistry – II, Credit-5, FM-100

Paper Code : Core-5T

Theory (T) : Credit – 3, Full Marks – 75 (ESE -50 + CE- 20 + Attendance-5)

#### A. Photochemistry

(12 Lectures)

Basic principles, Jablonski diagram, photochemistry of olefinic compounds, Cis-trans isomerisation, stereomutation Paterno-Buchi reaction, Norrish type I and II reactions, photoreduction of ketones, di- $\pi$ -methane rearrangement, photochemistry of arenes, Photoreaction in solid state. Method of generation and detection (ESR) of radicals, radical initiators, reactivity pattern of radicals, substitution and addition reactions involving radicals, cyclisation of radicals, allylic halogenation, autooxidation

#### B. Nucleophilic and Electrophilic Aromatic substitution:

(12 Lectures)

Aromatic Nucleophilic substitution:  $SN_1(Ar)$ ,  $SN_2(Ar)$ , and benzyne mechanisms; evidence for the structure of benzyne. Von Richter rearrangement. Definition and types of ambident nucleophiles. The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeier reaction, Gattermann-Koch reaction

#### C. Reagents in organic synthesis

(12 Lectures)

Use of following reagents in organic synthesis and functional group transformations – complex metal hydrides, Gilman's reagent, lithium dimethyl cuprate, LDA, DCC, Merrifield resin, Peterson's synthesis, Lawesson's reagent, Wilkinson's catalyst, Baker yeast., hypervalent organoiodines (introduction) and reagents of non-transition metals – Zn, Cd, Sm and In

#### D. Selective Name Reactions:

(12 Lectures)

Barton, Baylis Hillman reaction, Benzoin condensation, Chichibabin Reaction, Darzens reaction, Dieckman condensations, Grignard reactions. Henry reaction, Knoevenagel reaction, Mannich, McMurry, Perkin, Peterson olefination, Reformatsky and Reimer-Tiemann, Robinson Annulation. Stobbe, Stork enamine reaction and selective mono and di alkylation via enamines. Wittig and its modifications and other reactions, Oppenauer oxidation, Mitsunobu Reaction

Paper Name : Organic Chemistry– II

Paper Code : Core-4P

Practical (P) :

Credit – 2,

Full Marks – 25

Practical (P) :

(30 practical class)

#### Isolation / Estimation of natural products

1. Extraction of clove oil from cloves.
2. Estimation of glucose by Folin Wu method.
3. Estimation of citral using hydroxylamine hydrochloride.
4. Estimation of saponification value of oil.

#### Two stage preparations (any Ten)

1. Benzaldehyde  $\rightarrow$  Benzalacetophenone  $\rightarrow$  Epoxide
2. 4-Nitro toluene  $\rightarrow$  4-Nitro benzoic acid  $\rightarrow$  4-Amino benzoic acid
3. Resorcinol  $\rightarrow$  4-methyl-7-hydroxy coumarin  $\rightarrow$  4-Methyl-7-acetoxy coumarin
4. Hydroquinone  $\rightarrow$  Hydroquinone diacetate  $\rightarrow$  1,2,4-Triacetoxy benzene
5. Acetanilide  $\rightarrow$  p-Acetamidobenzene sulphonyl chloride  $\rightarrow$  p-acetamidobenzenesulphonamide



6. p-Amino phenol → p-Acetyl amino phenol → p-Ethoxy acetanilide
7. p-Cresol → p-Cresyl benzoate → 2-Hydroxy-5-methyl benzophenone
8. Phthalimide → N-Benzylphthalimide → Benzylamine
9. Aniline → Acetanilide → p-nitroacetanilide
10. Acetanilide → p-nitroacetanilide → p-nitroaniline
11. benzyl alcohol → benzaldehyde → benzoic acid
12. Phthalic acid → Phthalimide → Anthranilic acid
13. o-Nitroaniline → o-Phenylene diamine → Benzimidazole
14. Aniline → Acetanilide → p-bromoacetanilide

**Suggested Books:**

- Photochemistry and Pericyclic Reactions by Jagdamba Singh
- Organic Reactions and Orbital Symmetry by Gilchrist and Storr
- Some Modern Methods of Organic Synthesis W. Carothers, Third Edition, Cambridge University Press, Cambridge, 1988.
- Modern Organic Synthesis-an introduction by George S.Zweifel and Michael H. Nantz, W. H. Freeman & company, New York

## **Inorganic Chemistry**

**Paper Name : Inorganic Chemistry – II, Credit-5, FM-100**

**Paper Code : Core-5T**

**Theory (T) : Credit – 3, Full Marks – 75 (ESE -50 + CE- 20 + Attendance-5)**

**A. Metal-ligand equilibrium in Solution:**

**(12 lectures)**

Stability of mononuclear, polynuclear and mixed ligand complexes in solution. Stepwise and overall formation constants and their relations. Trends in stepwise formation constants, factors affecting the stability of metal complexes with reference to the nature of the metal ions and ligands. Statistical and non-statistical factors influencing stability of complexes in solution. Stability and reactivity of mixed ligand complexes with reference to chelate effect and thermodynamic considerations. Macrocyclic and template effect. Spectrophotometric and pH metric determination of binary formation constants

**B. Spectra of Complex:**

**(15 lectures)**

Orgel diagrams (qualitative approach), Tanabe-Sugano diagrams, selection rules for spectral transitions, relaxation of selection rule and band intensity, band width and shape, d-d spectra of  $d^n$  ions and crystal field parameters, measurement of  $10 Dq$  and  $B$ , nephelauxetic series, effect of Jahn-Teller distortion on spectra. Experimental evidence of metal-ligand overlap. MOT to rationalize  $\sigma$  and  $\pi$  interactions in octahedral, square planar and tetrahedral metal complexes. Symmetry designations of LGOs and MOs. Simplified MO diagrams

**C. Reaction Mechanism of inorganic complex:**

**(15 lectures)**

Some important rate laws of ligand substitution reaction, activation parameters ( $\Delta S^\ddagger$ ,  $\Delta H^\ddagger$ ,  $\Delta V^\ddagger$ ), mechanism of isomerization reaction, linkage isomerism, cis-trans isomerism, intramolecular and intermolecular racemization, Ray-Dutta and Bailar twist mechanisms, substitution in octahedral complexes- the Eigen-Wilkins mechanism, the Fuoss-Eigen equation, linear free energy relation (LFER) etc. conjugate base formation, anation reaction and base hydrolysis, reactions without metal-ligand cleavage. Substitution reactions in square planar complexes, Trans effect, mechanism of the substitution process, nucleophilicity parameter.

**D. Clusters-II**

**(8 lectures)**

Metal carbonyls and halide clusters, compounds with metal-metal multiple bonds, isopoly and heteropoly acids and their salts.

**Paper Name : Inorganic Chemistry–II**

**Paper Code : Core-6P**

**Practical (P) :**

**Credit – 2,**

**Full Marks – 25**

**Inorganic quantitative analysis:**

**(30 Classes)**

Separation and estimation of two metal ions from minerals, alloys or solutions.

**Suggested Books**

- Ligand field theory and its application by B. N. Figgis
- Inorganic chemistry, principal of structure and reactivity by J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi
- Inorganic Chemistry, 4th edition by C. E. Housecroft, A. G. Sharpe
- Inorganic Chemistry by Shriver and Atkins
- Inorganic Chemistry, Vol.- 5 by A. K. Das, M. Das
- Inorganic Chemistry, Vol.- 6 by A. K. Das, M. Das
- Elements of magnetochemistry by R. L. Dutta, A. Shyamal
- Inorganic Chemistry: Principles , D. Banerjee
- Hand book of Inorganic analysis, G. N. Mukherjee
- Vogel's Text Book of Quantitative Inorganic analysis, J. Bassett, R.C Denny, G. H Jefery& J. Mendham

**Physical Chemistry**

**Paper Name : Physical Chemistry – II, Credit-5, FM-100**

**Paper Code : Core- 7T**

**Theory (T) : Credit – 3, Full Marks – 75 (ESE -50 + CE- 20 + Attendance-5)**

**A. Quantum Chemistry – II**

**(20 lectures)**

The variational method, Eckart's theorem, Linear variational method, Perturbation theory (time independent), Application of variational method and nondegenerate perturbation theory to the helium atom problem. Electron spin, Antisymmetry principle, Spectroscopic term symbols, Spin-orbit coupling, Degenerate perturbation theory and its application to Zeeman and anomalous Zeeman effect, Stark effect.

**B. Computers for Chemists:**

**(15 lectures)**

Fundamentals of Computers, Elements of the computer language (FORTRON, BASIC, C), Constants and variables, Operations and symbols, Expressions, Arithmetic assignment statement, Input and Output format statement, Termination statements, Branching statements. Branching statements such as IF or GO TO statements of LOGICAL variables, Double precision variables. Subscripted variables and DIMENSION DO statement FUNCTION and SUBROUTINE COMMON and DO Statement FUNCTION and SUBROUTINE COMMON and DATA statements (above language features refer to FORTRON; may be changed appropriately for C / BASIC)

Development of small computer codes involving simple formulae in chemistry, such as equations for kinetics, radioactive decay etc, Evaluation of lattice energy and ionic radii from experimental data, Linear

simultaneous equations to solve secular equations within the Hückel theory. Elementary structural features such as bond lengths, bond angles, dihedral angles etc. of molecules extracted from a database such as Cambridge than base

**C. Electrochemistry**

**(15 lectures)**

Ion-association, Formation of ion-pairs, triplets etc; Ion-solvent interactions, The Born model, structural treatment of ion-solvent interactions, ion-quadruple theory of solvation, The solvation number, Debye-Hückel theory, Debye-Hückel-Onsager theory, Electrophoretic and relaxation effects, Wien effects, Debye – Fulckenhegen effect.

**Paper Name : Physical Chemistry– II**

**Paper Code : Core-7P**

**Practical (P) :**

**Credit – 2,**

**Full Marks – 25**

**Practical**

**(32 practical classes)**

1. Studies on alkalis hydrolysis of ethyl acetate conductometrically.
2. Determination of  $pK_1$  and  $pK_2$  of phosphoric acid potentiometrically.
3. Determination of  $pK_1$  and  $pK_2$  of phosphoric acid pH metrically.
4. Verification of Debye Hückel Onsager-equation.
5. Studies on the kinetics of reaction between  $K_2S_2O_8$  and KI spectrophotometrically.
6. Studies on the kinetics of reaction between  $KBr_3$  and  $KBr$  titrimetrically.
7. Potentiometric estimation of Fe (II) using  $K_2Cr_2O_7$ .
8. Ternary phase diagram of  $H_2O/C_6H_6/CH_2COOH$ .

**Suggested books**

- Quantum Chemistry by A B Sannigrahi
- Modern Electrochemistry-Vol-1 by John OM Bockris, Amulya K. N. Reddy
- Practical Physical Chemistry by Renu Gupta (New Age International Publisher)
- An Advanced Course in Practical Chemistry by A.K. Nad, B. Mahapatra, A. Ghoshal

**Advanced Spectroscopy**

**Paper Name : Advanced Spectroscopy, Credit-5, FM-100**

**Paper Code : Core-8T**

**Theory (T) : Credit – 4, Full Marks – 75 (ESE -50 + CE- 20 + Attendance-5)**

**A. Molecular Symmetry and Group theory**

**(15 lectures)**

Symmetry elements and symmetry operations, Group theory: definitions and theories, multiple symmetry operations, multiplication table, molecular point groups, Simple ideas of representation and character table, direct product.

**B. <sup>13</sup>C NMR spectroscopy; CD, ORD; ESR, Mössbauer & EXAFS (20 lectures)**

**C. NMR Spectroscopy of inorganic compounds (15 lectures)**

<sup>1</sup>H NMR spectra of paramagnetic coordination compounds, dipolar and contact shifts, magnetic susceptibility and resonance shifts. <sup>11</sup>B, <sup>19</sup>F, <sup>27</sup>Al, <sup>31</sup>P, <sup>51</sup>V – NMR spectra. Pascal triangle, Contact shifts. Factors contributing the magnitude of chemical shift. NMR shift reagent and MRI reagent. Applications of NMR spectroscopy in inorganic systems.

**D. Fluorescence spectroscopy (10 lectures)**

Principles of fluorescence spectra, Jabonlaski diagram, mirror image rule, intersystem crossing, selection of exciting wavelength, quantum yield, effect of temperature, solvent polarity and viscosity, quenching of fluorescence, inner-filter effect, fluorescence of biomolecules,

### **Paper Name : Advanced Spectroscopy**

**Paper Code : Core-8P**

**Practical (P) :**

**Credit – 1,**

**Full Marks – 25**

**Practical**

**(15 practical classes)**

A. Assignment of NMR peaks of selected organic and inorganic compounds (selected by the concerned teachers).

B. collection of UV-visible spectra of the following compounds:

[Curcumin, caffeine of tea/coffee, cinnamaldehyde, Eugenol and related organic compounds. synthesized nano particles, Cobalt acetylacetonate, cis and trans [Co(en)<sub>2</sub>Cl<sub>2</sub>], cis and transCu(glycinato)<sub>2</sub> CuSO<sub>4</sub>, Cu(acac)<sub>2</sub>.H<sub>2</sub>O and related inorganic compounds.]

#### **Suggested Books**

- Application of absorption spectroscopy of Organic Spectroscopy: J. R. Dyer
- Organic Spectroscopy: W. Kemp
- Fundamentals of Molecular Spectroscopy : C. N. Banwell
- Fundamentals of photochemistry : K. K. Rohatgi-Mukherjee
- Introduction to Molecular spectroscopy: G M Barrow
- Fundamental concepts of inorganic chemistry, vol - 7, A. D. De
- Physical methods in inorganic chemistry: R. S. Drago

## Semester-III

Paper Name : Organic & Inorganic Chemistry, Credit-5, FM-100

Paper Code : Core-9T

Theory (T) : Credit – 5, Full Marks – 100 (ESE -50 + CE- 20 + Attendance-5 + Viva 25)

### Group-A (Organic)

#### A. Heterocyclic Chemistry

(10 lectures)

Nomenclature of bicyclic and tricyclic fused systems ; Introduction to the chemistry of azepines, oxepines, thiophenes and their aza analogues; Phosphorus and selenium containing heterocycles, Cyclazines. Synthesis and reactions of Aziridines, azetidines, oxazoles, thiazoles, imidazoles, isoxazoles, isothiazoles, pyrazoles, Pyridine, quinoline, Isoquinoline, Imidazole, Benzofuran, Benzothiophene, Pyrazole, Indoles, pyrimidines, pyridazines, pyrazines, purines, isothiazole, pteridines compounds and higher azoles and corresponding fused systems. Role of heterocyclic compounds in biological systems.

#### B. Oxidative processes and Reductive processes

(15 lectures)

**Oxidation of functional groups:** Synthetic applications of the following reagents in the oxidation of functional groups like alkenes, alkynes, alcohols, aldehydes and ketones: 1) Oxidations by using DMSO involving alkoxy sulphonium salts (Kornblum oxidation), DCC-DMSO (Pfitzner-Muffat reagent), Swern oxidation, Corey-Kim oxidation, Albright-Goldman oxidation 2) Oxidations by using IBX, DMP, TEMPO, 3) Oxidation by using DDQ 4)  $\text{Pb}(\text{OAc})_4$  5)  $\text{HIO}_4$  6)  $\text{SeO}_2$  7)  $\text{CrO}_3$  (Sodium or potassium dichromate in  $\text{H}_2\text{SO}_4$ , Collins reagent, Jones reagent, Etard reagent,  $\text{CrO}_3$  in acetic anhydride, PCC (Corey's reagent), PDC, (Babler oxidation), 8)  $\text{MnO}_2$  9)  $\text{KMnO}_4$  10)  $\text{OsO}_4$  11) CAN 12) TPAP, 13) Baeyer-villiger oxidation and Prilzhev epoxidation 14) Oxidation of alkenes using Woodward and Prevost reagents 15) Thallium nitrate 16) Oxidative coupling of phenols and alkynes 17) Oxidations with ruthenium tetroxide.

**Reduction of functional groups:** (1) Catalytic reductions: Homogeneous (Wilkinson's Catalytic reduction) and heterogeneous catalytic reductions and their synthetic applications. (2) Reductions by using electrophilic nucleophilic metal hydrides:  $\text{LiAlH}_4$  (Various examples of reductions and Cram's rule), related reagents of LAH,  $\text{NaBH}_4$ ,  $\text{NaBH}_3\text{CN}$ , Trialkyl Borohydrides (Super Hydride and Selectride). (3) Reductions by using electrophilic metal hydrides:  $\text{BH}_3$ , DIBAL. (4) Reductions by dissolving metals: Clemmenson reduction, Acyloin condensation, Bouveault-Blanc reduction, Birch reduction (Various examples should be discussed). (5) Reductions by using Diimide and Wolf-Kishner Reduction and Huang-Minlon modification (6) Hydrogenolysis (7) Reductions by using tri n-butyl tin hydride.

#### C. Organometallic Reagents

(15 lectures)

Principle, preparations, properties and application of organometallic compounds of transition elements – Cu, Pd, Ni, Fe, Co, Rh, Ru, Cr and Ti in organic synthesis and in homogeneous catalytic reactions (hydrogenation, hydroformylation, isomerisation and polymerization), structure and mechanistic aspects, Davies rule, catalytic nucleophilic addition and substitution reaction, coupling reaction – Heck, Stille, Suzuki coupling, Sonogashia, Buchwald-Hartwig, Hiyama, Glazer-Eglinton coupling, Ziegler Natta reaction, Walker Process, Olefin metathesis, Tebbe's reagent, Pauson-Khand reaction, functional organometallic compounds, pi-acid metal complexes, activation of small molecules by coordination.

#### Suggested Books:

- Heterocyclic chemistry: AR Katritzsky
- Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley
- T.L. Gilchrist, Heterocyclic Chemistry. John Wiley & Sons, (1987).

## Group-B (Inorganic)

### A. Organometallic compounds of main group elements (10 lectures)

Synthesis, properties and structures of organometallic compounds of group-I to group-III elements of the periodic table. Synthesis, properties and structures of organometallic compounds of group-IV & V elements of the periodic table.

### B. Magnetochemistry: (15 lectures)

Basic principles of magnetism, Magnetic properties, paramagnetism, ferro- and antiferro magnetism, diamagnetism, Pascal constants, Curie equation, Russell-sander's terms, determination of magnetic susceptibility, application of Van Vleck susceptibility equation, Magnetic properties of first transition series metal ions, Spin and orbital moments, spin – orbit coupling, quenching of orbital moment, spin only formula, room temperature and variable temperature magnetic moments and spin crossover.

### C. Electron transfer reaction: Mechanism of electron transfer reactions: (12 lectures)

General characteristics and classification of redox reactions, self-exchange reactions. Frank-condon principle (non mathematical treatment). Outer sphere and Inner sphere reactions, applications of Marcus expression (simple form), redox catalyzed substitution reactions.

#### Suggested Books

- Fundamental Concept of Inorganic Chemistry Vol-5, A. K De.
- Magnetism & Transition metal complexes F.E Mabbs D J. Machin Dover Publications, Inc.
- Elements of Magnetism Dutta & Syamal, (2019) EW Press
- Basic organometallic chemistry 2<sup>nd</sup> Edition, (2013) B. D. Gupta & A. J. Elias, University Press,
- Kinetics and Mechanism of Reactions of Transition Metal Complexes; Ralph G. Wilkins, Wiley-VCH Verlag GmbH & Co.
- Modern physical Organic chemistry, EV Enslin & DA Dougherty, University Science Book

## Semester-III (special)

### DCE-IA

**Paper Name : Organic Chemistry special-I, Credit-5, FM-100**

**Paper Code : DCE-IA**

**Theory (T) Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance 5 + Seminar 25)**

### A. Advanced NMR Spectroscopy (22 lectures)

Application of DEPT, <sup>1</sup>H- <sup>1</sup>H COSY, HETCOR, TOCSY, NOESY, ROESY in structure elucidation of organic compounds, drug screening, reaction monitoring etc. q - NMR & DOSY. Problems based on combined use of spectroscopic techniques/ advanced techniques.

### B. Synthetic Strategy (15 lectures)

Retrosynthetic analysis, disconnection approach, Typical examples to illustrate the disconnection approach, Functional group interconversion, Convergent synthesis.

**C. Modern aspects of organic reaction:** (18 lectures)

**Multi-component reactions:** Biginelli, Strecker synthesis, Hantzsch pyridine synthesis, Multicomponent reactions using alkyl isocyanides: Passerini and Ugi-4-components synthesis.

**Click chemistry:** criterion for click reaction, Sharpless azides cycloadditions, Domino/cascade reactions.

**D. Reactions of organoboranes** (20 lectures)

Organoboranes: Preparation of Organoboranes viz hydroboration with  $\text{BH}_3\text{-THF}$ , dicyclohexyl borane, disiamyl borane, teryl borane, 9-BBN mono isopinacamplyl borane ( $\text{IPC}_2\text{BH}_2$ ) and diisopinacamplyl borane ( $\text{IPC}_2\text{BH}$ ) functional group transformations of Organo boranes-Oxidation, protonolysis and isomerisation. Formation of carbon-carbon-bonds viz organo boranes carbonylation and cyanidation, reactions of alkenyl boranes and trialkylalkynylborates.

**Suggested Books**

- Spectroscopic Identification of Organic Compounds
- Organic Spectroscopy by William Kemp, ELBS 3rd Ed. 1994
- Supramolecular Chemistry: from Molecules to Nanomaterials Eds. by P.A. Gale and J.W. Steed (2012).
- Modern Supramolecular Chemistry by F. Diederich, P. J. Stang, R. T. Tykwinski (2008)
- J.A Joule and K.Mills, Heterocyclic Chemistry, Fourth edition, Blackwell Science Ltd, (2000).
- Organometallics by Ch. Elschenbroich, A. Salzer, VCH, 1995, 2nd Ed
- Organotransition Metal Chemistry: Fundamental Concepts and Applications by A. Yamamoto, John Wiley 1986
- Organometallic Chemistry of the Transition Metals by R. H. Crabtree, John Wiley, 1993, 2nd Ed.

**DCE-IIA**

**Paper Name : Organic Chemistry Special-II, Credit-5, FM-100**

**Paper Code : DCE-IIA**

**Practical (P) Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance 5 + Project 25)**

**Quantitative estimations:**

1. Estimation of phenol, aniline, ethyl methyl ketone, Glucose (iodimetry method and Bertrand's method).
2. **Separation of a solid mixture using column chromatography technique**
3. Separation of solid components of a mixture (by column chromatography) based upon differences  $R_f$  values.
4. Reporting the melting point, polarity (TLC) of the isolated compounds.
5. Calculation of percentage isolated yields of the individual components. (Identification of the components are not required).

**Students have to opt for project work at the University.**

## DCE-IB

**Paper Name : Inorganic Chemistry special-I, Credit-5, FM-100**

**Paper Code : DCE-IB**

**Theory (T) Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance 5 + Seminar 25)**

- A. Quantum chemistry: (12 lectures)**  
Many electron treatment, Pure-spin states, Slater-Condon rules, Hartree-Fock theory, Hartree-Fock-Roothan method, Basic functions, Electron correlation, Configuration interaction, Born-Oppenheimer approximation, Introduction to Density function theory.
- B. Solid state chemistry-I (12 lectures)**  
Theory of crystalline solids, point defects – Schottky and Frenkel defects, free electron model and its limitations, Kronig Penny model, Band theory, band gap, metals, Insulators, Semiconductors, P-N junction semi-conductors (intrinsic and extrinsic) materials, Superconductors, rectifiers and transistors.
- C. Chemistry of Actinides. (06 lectures)**
- D. Organotransition metal chemistry-I (10 lectures)**  
Alkyls and aryls of transition metals. Compounds of transition metal-carbon multiple bonds. Transition metal  $\pi$  complexes.
- E. Photoinorganic Chemistry (10 lectures)**  
Basics of photochemistry, properties of excited states, excited states of metal complexes, ligand field photochemistry, redox reactions by excited metal complexes, metal complex sensitizers, photo-splitting of water and solar energy conversion/storage.
- F. Bio-inorganic Chemistry-I: (15 lectures)**  
Transport and storage of di-oxygen: hemoglobin, myoglobin, hemerythrin and hemocyanine. Electron transfer in biology: Structure and functions of metalloproteins in electron transfer process: iron-sulphur proteins, cytochromes, Photosynthesis: PS-I & PS-II, nitrogenase, metal ion storage and transport, metalloenzymes, Na<sup>+</sup>/K<sup>+</sup> pumps.
- G. Molecular symmetry and group theory: (12 lectures)**  
Schonflies symbols, representation of groups by matrices, character of a representation, the great orthogonality theorem (without proof) and its importance, character tables and their use.

### Suggested Books

- Ligand field theory and its application by B. N. Figgis
- Inorganic chemistry, principal of structure and reactivity by Huheey, Keiter, Keiter, Medhi
- Inorganic Chemistry, 4th edition by C. E. Housecroft, A. G. Sharpe
- Inorganic Chemistry by Shriver and Atkins
- Inorganic Chemistry, Vol.- 5 by A. K. Das, M. Das
- Chemistry of elements by N. N. Greenwood and A. Earnshaw
- Molecular Symmetry and Group theory: F. A Cotton
- S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, University Science Books, 1994
- Bioinorganic Chemistry I Bertini, H B Gray, S J Lippard, J S Valentine, Viva Publishing, New Delhi.
- Biochemistry, 4<sup>th</sup> Edition, Lubert Stryer. W H Freeman & Co.
- Solid State Chemistry, A R west.
- New direction in solid state chemistry C N R Rao and J Gopalkrishanan, 2<sup>nd</sup> Ed, Cambridge University Press



## DCE-IIB

**Paper Name : Organic Chemistry special-II, Credit-5, FM-100**

**Paper Code : DCE-IIB**

**Practical (P) Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance 5 + Project 25)**

**Practical : (75 practical classes with project work)**

Preparation of inorganic compounds and their study by IR, electronic, Mössbauer, ESR spectra and magnetic susceptibility measurements, handling of air and moisture sensitive compounds involving vacuum lines. Selection can be made from the following or any other compound as selected by the teacher concerned: (Experiments will be set depending upon the availability of instruments and materials)

1. Sodium amide.
2. Synthesis and thermal analysis of group II metal oxalate hydrate, atomic absorption analysis of Mg and Ca.
3. Trialkoxyboranes- Preparation, IR and NMR spectra.
4. Dichlorophenylborane-synthesis in vacuum line.
5. Preparation of Tin (IV) iodide, Tin (IV) chloride and Tin (II) iodide.
6. Relative stability of Tin (IV) and Pb (IV): Preparation of ammonium hexachlorostannate, ammonium hexachloroplumbate.
7. Hexa-bis (4-nitrophenoxy) cyclotriphosphazene.
8. Synthesis of trichlorodiphenylantimony (V) hydrate.
9. Sodium tetrathionate.
10. Metal complexes of dimethyl sulphoxide-  $\text{CuCl}_2 \cdot 2\text{DMSO}$ ,  $\text{PdCl}_2 \cdot 2\text{DMSO}$ ,  $\text{RuCl}_2 \cdot 4\text{DMSO}$ .
11. Synthesis of metal acetylacetonate: Magnetic moment, IR, NMR.
12. Bromination of  $\text{Cr}(\text{acac})_3$ .
13. Magnetic moment of  $\text{Cu}(\text{acac})_2 \cdot \text{H}_2\text{O}$ .
14. Cis and Trans  $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ .
15. Separation of optical isomer of cis- $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$ .
16. Ion-exchange separation of oxidation state of vanadium.
17. Preparation of N, N-bis-(salicylaldehyde) ethylenediamine,  $\text{Co}(\text{salen})$ , determination of  $\text{O}_2$  absorption by  $\text{Co}(\text{salen})$ , reaction of oxygen adduct with  $\text{CHCl}_3$  (deoxygenation).
18. Preparation of Fe (II) chloride.
19. Reaction of Cr (III) with a multidentate ligand: a kinetics experiment
20. Preparation of  $[\text{Co}(\text{phenanthroline-5,6-quinone})]$ .
21. Preparation and use of Ferrocene.
22. Preparation of copper glycine complex- cis and trans bis- (glycinato) copper (II).
23. Preparation of phosphine and its transition metal complexes.
24. Preparation of tetraphenyltin.

**Students have to opt for project work at the University.**

## DCE-IC

**Paper Name : Physical Chemistry special-I, Credit-5, FM-100**

**Paper Code : DCE-IC**

**Theory (T) Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance 5 + Seminar 25)**

- A. Quantum Chemistry- III** (25 lectures)  
Hückel M.O. theory for conjugated systems, bond order and charge density calculations, Electron spin, Antisymmetry principle, Pure-spin states, Introduction to the method of self consistent Field, Hartree method, Koopman's theorem. Many electron treatment.
- B. Molecular Spectroscopy** (20 lectures)  
Time dependent perturbation theory: Harmonic – perturbation and Fermi golden rule, Einstein's coefficients of induced emission and absorption, molecular term symbols, Electronic spectra of polyatomic molecules.  $n \rightarrow \pi^*$ ,  $\pi \rightarrow \pi^*$ , CT transition, Effect of solvent, Vibronic progression, Oscillator strength, Luminescence and energy transfer processes, Mössbauer Spectroscopy, Photoelectron spectroscopy, Theory and applications to magnetic resonance spectroscopy (NMR, ESR etc)
- C. Statistical Thermodynamics** (23 lectures)  
Concept of distribution, thermodynamic probability and most probable distribution, Description of states - Phase Space. Statistical Ensemble, Density distribution in phase space, Ensemble averaging, postulates of ensemble averaging, Canonical, grand canonical and micro canonical ensembles, corresponding distribution laws (using Lagrange's method of undermined multipliers). Partition functions - translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions. Applications of partition functions - heat capacity behaviour of solids, chemical equilibria and equilibrium constant in terms of partition functions.
- D. Quantum statistical thermodynamics and non-equilibrium Statistical Mechanics:** (12 lectures)  
Classical Approximations, Validity of Classical Approximations. Weakly and strongly degenerate systems. Fermi-Dirac statistics - distribution law and applications to metal; Bose-Einstein statistics - distribution law and application to helium (Bose-Einstein condensation). Elementary ideas of Brownian motion, Einstein theory, relation between diffusion and mobility.

**Suggested books:** (given in 4<sup>th</sup> semester)

## DCE-IIC

**Paper Name : Physical Chemistry Special-II, Credit-5, FM-100**

**Paper Code : DCE-IIC**

**Practical (P) Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance 5 + Project 25)**

**Practical :** (75 classes)

1. Determination of CMC and micellization parameters of an ionic surfactant conductometrically.
2. Studies on the effect of ionic strength on the micellization of SDS.
3. Spectral studies on Py - I<sub>2</sub> charge transfer complex.
4. Determination of the activation energy of the reaction between K<sub>2</sub>S<sub>2</sub>O<sub>8</sub> and KI.

5. Determination of the activation energy of the reaction between  $\text{KBrO}_3$  and  $\text{KBr}$ .
6. Determination of isoelectric point of gelation viscometrically
7. Determination of  $E^\circ$  of  $\text{Ag}^+/\text{Ag}$  electrode and solubility product of  $\text{AgCl}$ .
8. Estimation of  $\text{Cl}^-$ ,  $\text{Br}^-$  and  $\text{I}^-$  in a mixture potentiometrically.
9. Determination of coordination number of  $\text{Ag}^+$  ion in  $\text{Ag}$ -ammine complex potentiometrically.
10. Determination of composition of  $\text{Fe}^{2+}$ - salicylate complex by Job's method.

**Students have to opt for project work at the University.**

## Semester-IV

**Paper Name : Physical, Analytical and Industrial Chemistry, Credit-5, FM-100**

**Paper Code : Core-10T**

**Theory (T) : Credit – 5,**

**Full Marks – 100 (ESE -50 + CE- 20 + Attendance-5 + Industry/Academia Visit - 25)**

### A. Physical Chemistry

**X-ray diffraction and Solid State** (15 lectures)

Bragg-Miller indices, X-ray structural analysis of crystals, identification of unit cells, structure of simple lattices and X-ray intensities, Defects in solids: point, line and plane defects, Determination of equilibrium concentration of Schottky and Frenkel defects, F-centres/color-centres in ionic crystals, Band theory of solids, Semiconductors (extrinsic and intrinsic), hopping semi-conductors, rectifiers, transistors, Super conductivity, Organic conducting solids, solid state reactions.

### B. Analytical Chemistry

(20 lectures)

Spectrophotometry.

Thermal methods of analysis.

Radioactive methods of analysis.

Fluorimetry, nephelometry, turbidometry and atomic absorption spectroscopy.

Selected analytical techniques-I Solvent extraction, High performance liquid chromatography (Brief ideas). Ion exchange chromatography, Electro-analytical techniques

### C. Industrial Chemistry

(15 lectures)

Energy Systems Chemical energy sources and their limitations (natural gas, coal, nuclear fission, nuclear fission and Hydro power). Electrochemical energy systems-Introduction, classification, battery characteristics. Primary batteries-Laclanche dry cell ( $\text{Zn}$  and  $\text{Mg}$ ), Alkaline  $\text{MnO}_2$  batteries. Secondary batteries-Introduction, lead acid battery, Alkaline storage battery. Lithium batteries-The primary & secondary lithium batteries. Lithium based conducting polymer battery. Fuel cells-Introduction, efficiency, classification and types ( $\text{H}_2$ - $\text{O}_2$  fuel cell, methanol fuel cell, solid polymer electrolyte fuel cell biofuel cell).

Non conventional energy systems: Solar energy cells-Introduction, semiconductor electrodes, semiconductor-electrolyte interface, parameter controlling efficiency, stability of semiconductor electrodes, Photoelectrochemical and photogalvanic cells. Production of Hydrogen, hydrogen energy. Applications of photochemistry-photoelectrocatalysis, photoreduction of CO<sub>2</sub> and photoelectrochemical waste removal. Hydrogen storage by metal and metal-alloys

## Semester-IV (special)

**Paper Name : Organic Chemistry special-III, Credit-5, FM-100**

**Paper Code : DCE-III A**

**Theory (T) Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance 5 + Seminar 25)**

### A. Asymmetric synthesis on chiral substrate:

Nucleophilic addition to  $\alpha$ -chiral carbonyl compounds; Prediction of stereochemistry-Cram's rule and related modifications. Double stereo differentiation; matched pair and mismatched pair; examples from aldol condensation and hydroboration reactions. Electrophilic addition to  $\alpha$  - chiral olefins - epoxidation, cyclopropanation, hydroboration - oxidation, alkylation of enolates of  $\beta$ -chiral carbonyl compounds.

Chiral modification of lithium aluminum hydride, BINAL-H - application in reduction of prochiral ketones; oxazaborolidines. T.S model; Asymmetric Michael addition to  $\alpha, \beta$  - unsaturated carbonyl compounds T.S model; chiral lithium amides - enantioselective deprotonation.

Asymmetric synthesis using chiral auxiliary: Chiral auxiliaries derived from proline, camphor, menthol and other chiral pool sources. SAMP / RAMP hydrazines, and other pyrrolidines, oxithiane, oxazolidine-2-one, thiazolidine-2-one, phenylethylamine, 2-phenylcyclohexanol, 8-phenyl menthol. Asymmetric synthesis using chiral catalysts: Asymmetric alkylation and allylation of carbonyl compounds, chirality amplification, non-linear effects: Selected reactions: DAIB, Keck's allylation, TADDOLs and other privileged ligands. Asymmetric hydrogenation: early advances DIPAMP, DIOP and Noyori's BINAP - selected reactions / examples. Proline mediated aldol reactions and further expansion in the field of organo catalysis. Sharpless epoxidation, dihydroxylation, aminohydroxylation of alkenes; Utility metal-semicorrinato complexes and Jacobson catalysts - Evans catalyst - Aziridination.

Asymmetric aldol reaction: Diastereoselective aldol reaction and its explanation by Zimmermann - Traxel model. Auxiliary controlled aldol reaction. Double diastereo selection - matched and mismatched aldol reactions.

### B. Principles and applications of ultrasound and microwaves in organic synthesis.

### C. Advanced spectroscopic techniques:

<sup>19</sup>F- NMR and <sup>31</sup>P- NMR spectroscopy: Principles and applications.

### D. Protecting groups and simple applications

- Protection of alcohols as ethers [methyl ether (RO-Me), Tertiary butyl ether (ROMe<sub>3</sub>), Benzyl ethers (RO-Bn), p-methoxybenzylethers (RO-PMB)], as Silyl ethers [Trimethyl silylether (R-OTMS), tri ethyl silyl ethers (RO-TES), t-butyl dimethylsilyl ether (R-OTBDMS in the presence of imidazole), tri isopropylsilyl ether (RO-TIPS), t-butyl diphenylsilyl ether (RO-TBDPS)], as

acetals[tetrahydropyranyl ethers (RO-THP), methoxymethyl ethers (RO-CH<sub>2</sub>-OCH<sub>3</sub>= RO-MOM)and ester formation(carboxylic acid ester and p-toluene sulphonate esters).

- b. Protection of 1,2-diols by acetal, ketal and carbonate formation.
- c. Protection of amines by acetylation, benzylation, benzoyloxy carbonyl, FMOC and triphenyl methyl groups.
- d. Protection of carbonyl by acetal, ketal and thio acetal (Umpolung) groups.
- e. Protection of carboxylic acids by esters and ortho ester formation

### **Suggested Books:**

- Modern Synthetic Reactions, Herbert O. House, Second Edition, W.A. Benjamin Inc. Menlo Park, California, 1972.
- Organic Synthesis: Special Techniques, V. K. Ahluwalia and Renu Agarwal.
- Organic Synthesis, Jagadamba Singh and Dr. A. Yadav, Pragati Edition.

**Paper Name : Organic Chemistry special-IV, Credit-5, FM-100**

**Paper Code : DCE-IVA**

**Practical (P) Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance 5 + Project 25)**

#### **1. Estimation of drugs**

- i. Estimation of penicillin by iodometric titrations.
- ii. Estimation of paracetamol by hydrolysis.
- iii. Estimation of diazepam by non-aqueous titrations.
- iv. Estimation of vitamin C by iodometric titrations.

#### **2. Estimation of drugs by UV method:**

- i. Estimation of streptomycin using uv-visible spectrophotometer.
- ii. Estimation of aspirin in the given tablet using uv-visible spectrophotometer.
- iii. Estimation of proteins by Biuret method using spectrophotometer.

#### **Interpretation of spectral data of organic compounds**

**(UV, IR, PMR, CMR and Mass spectra).**

A student will be given UV, IR, PMR, CMR, and Mass spectra of a compound from which preliminary information should be reported within first half an hour of the examination without referring to any book/reference material. The complete structure of the compound may then be elucidated by referring to any standard text-book/reference material etc.

**Students have to opt for project work at the University/Institute/Industry.**

## DCE-IIIB

**Paper Name : Inorganic Chemistry special-III, Credit-5, FM-100**

**Paper Code : DCE-IIIB**

**Theory (T) Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance 5 + Seminar 25)**

- A. **Solid state chemistry-II** (12 lectures)  
Solid state reactions, general principles, Crystal defects and non-stoichiometry of inorganic compounds, colour centre, photographic process, phosphors.  
Crystal morphology: Important minerals and different types of silicates: structural and physical properties.
- B. **Organotransition metal chemistry-II** (8 lectures)  
Transition metal compounds with bonds to hydrogen. Organometallic catalysts. Fluxional organometallic compounds
- C. **Chemistry of non-transitional elements (rings, sheet, polymers)** (10 lectures)  
Compounds with B-N bonds, P-N bonds and S-N bonds.
- D. **Chemical bonding-II** (10 lectures)  
Charge transfer spectra, electron absorption spectra,  $d^1$  and  $d^9$  systems, multi-electron systems, Tanabe-Sugano diagrams for various  $n d$  - configurations, ACFT
- E. **Chemistry of the missing elements** (5 lectures)
- F. **Advanced Bioinorganic Chemistry:** (18 lectures)  
Metal ion interactions with purine and pyrimidine bases, nucleosides, nucleotides and nucleic acids, DNA and RNA, metal ions in genetic information transfer.  
Redox enzymes: Catalase, peroxidase, super oxide dismutase (SOD), cytochrome P-450, nitric oxide synthases (NOS), ascorbate oxidase, aldehyde oxidase; molybdo enzymes: xanthene oxidase, nitrate reductase, sulfite oxidase including some model study.  
Vitamins and coenzymes: Vitamin B6 and vitamin B12 coenzymes, model systems
- G. **Magnetochemistry-II:** (10 lectures)  
Magnetic properties of lanthanides and actinides, anomalous magnetic moment, magnetic exchange coupling. magnetic exchange interactions. Basic concept of Single Molecule Magnets (SMM), properties and examples of SMMs.

### **Suggested Books:**

- Ligand field theory and its application by B. N. Figgis
- Inorganic Chemistry, 4th edition by C. E. Housecroft, A. G. Sharpe
- Chemistry of elements by N. N. Greenwood and A. Earnshaw
- Basics of Organometallic, Gupta & Elias, 2<sup>nd</sup> edition, University Press
- Principles of Bioinorganic Chemistry, S. J. Lippard & Berg, University Science Books, 1994
- Bioinorganic Chemistry I Bertini, H B Gray, S J Lippard, J S Valentine, Viva Publishing Delhi.
- Biochemistry, 4<sup>th</sup> Edition, Lubert Stryer. W H Freeman & Co.
- Solid State Chemistry, A R west.
- New direction in solid state chemistry C N R Rao and J Gopalkrishanan, 2<sup>nd</sup> Ed, Cambridge University Press
- Electronic spectra of transition metal complexes R K Roy New Central Book Agency
- Magnetism and transition metal complexes, Mabbs & Machin, Dover Publishing, Inc, NY.

**: Paper Name : Inorganic Chemistry special-IV, Credit-5, FM-100**

**Paper Code : DCE-IVB**

**Practical (P) Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance 5 + Project 25)**

**Practical/Project work :**

(75 classes)

Quantitative analysis. 2) Techniques like ion exchange, chromatography, solvent extraction, spectrophotometry, flamephotometry, nephelometry etc.

**Students have to opt for project work at the University/Institute/Industry**

### **DCE-IIIC**

**Paper Name : Physical Chemistry special-III, Credit-5, FM-100**

**Paper Code : DCE-IIIC**

**Theory (T) Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance 5 + Seminar 25)**

#### **A. Quantum Chemistry- IV**

Many electron treatment, Pure-spin states, Slater-Condon rules, Hartree-Fock theory, Hartree-Fock-Roothaan method, Basis functions, Electron correlation, Configuration interaction, Born-Oppenheimer approximation, Introduction to Density functional theory.

#### **A. Group theoretical representation and spectroscopy**

Reducible and irreducible representations, classes and characters, Great Orthogonality and related theorems, Projection operator, Direct product representation. Applications: SALC, Spectroscopic selection rules, Polyatomic vibration and normal modes, Identification of Infrared and Raman active vibrations.

#### **A. Chemical Kinetics**

Theories of unimolecular reactions: Lindemann, Hinshelwood, Rice-Ramsperger-Kassel (RRK) and Rice-Ramsperger-Kassel-Marcus (RRKM) theories.

#### **B. Non-equilibrium Thermodynamics**

Thermodynamic criteria for non-equilibrium process, Entropy production and entropy flow, Entropy balance equations for heat flow, chemical reactions etc., Transformations of the generalized fluxes and forces, Nonequilibrium stationary states, Generalized flux and forces, Phenomenological equations, Onsager reciprocal relations, Principle of detailed balance, Electro kinetic phenomenon, Diffusion, Electric conduction, Transport number and electrochemical cells, Irreversible thermodynamic for biological systems.

#### **C. Surface Chemistry**

Surface tension, curved surfaces, Young-Laplace and Kelvin equations. Adsorption on solids, micelles reverse micelles, microemulsion, Thermodynamics of micellization, Application of micelles and microemulsion.

**Paper Name : Physical Chemistry special-IV, Credit-5, FM-100**

**Paper Code : DCE-IVC**

**Practical (P) Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance 5 + Project 25)**

**Practical :**

1. Determination of  $pK_a$  of methyl red indicator spectrophotometrically.
2. Determination of  $pK_a$  of phenolphthalein indicator spectrophotometrically.
3. Study the effect of ionic strength on the kinetics of  $K_2S_2O_8 + KI$  reaction.
4. Study on the effect of ionic strength on the kinetics of  $KBrO_3 + KBr$  reaction.
5. Study the kinetics of inversion of cane sugar polarimetrically.
6. Tensiometric study on the micellization of a nonionic surfactant.
7. Experiments on: Computer application in solving different physicochemical problems.

**Students have to opt for project work at the University/Institute/Industry**

**Text/Reference Books:**

1. Quantum Chemistry ---- A.B. Sannigrahi
2. Quantum Chemistry ---- I.N. Levine
3. Quantum Chemistry ---- R.K. Prasad
4. Quantum Chemistry ---- Donald A McQuarrie
5. Elementary Quantum Chemistry ---- Frank L Pilar
6. Molecular Quantum Mechanics ---- P. Atkins and R. Friedman
7. Introduction to Quantum Mechanics ---- Linus Pauling and E. Bright Wilson
8. Quantum Mechanics in Chemistry ---- G. C. Schatz and M. A. Ratner
9. Introduction to quantum Chemistry ---- A. K. Chandra
10. Physical Chemistry, Quantum Chemistry and Molecular Interactions ---- Andrew Cooksy
11. Quantum Chemistry and Spectroscopy ---- Thomas Engel
12. Chemical Applications of Group Theory ---- F. A. Cotton
13. Group Theory and Chemistry ---- David M. Bishop
14. Molecular Symmetry and Group Theory ---- Robert L. Carter
15. Symmetry and Spectroscopy ---- B. C. Harris and M. D. Bertolucci
16. Group Theory and Quantum Mechanics ---- Michael Tinkham
17. Fundamentals of Molecular Spectroscopy ---- C.N. Banwell and E.M. McCash
18. Introduction to Molecular Spectroscopy ---- G.M. Barrow
19. Fundamentals of Photochemistry ---- K.K. Rohatgi-Mukherjee
20. Principles of Molecular Photochemistry ---- N.J. Turro, V. Ramamurthy and J.C. Scaiano

**Suggested Books:**

21. Unimolecular Reactions, 2<sup>nd</sup> ed----- K. A. Holbrook, M.J. Pilling, S.H. Robertson.
22. A Textbook of Physical Chemistry, Volume 5 -----K. L. Kapoor
23. Chemical Kinetics----- Keith J. Laidler
24. Chemistry by Computer----- Stephen Wilson
25. Biophysical Chemistry-----James P. Allen
26. Principles of Physical Biochemistry ---- K.E. van Holde, C. Johnson, P.S. Ho.
27. Principles of Biochemistry -----A. Lehninger, D. L. Nelson, M. M. Cox
28. Solid State Chemistry-----L. E. Smart, E.A. Moore
29. Principle Of Polymer Chemistry----- P..J.Flory



30. An Introduction to X-ray crystallography-----M. M. Woolfson
31. Thermodynamics For Chemists ----- S. Glasstone
32. Textbook of Polymer Science ----- F. W. Billmeyer Jr.
33. Molecular Thermodynamics ----- D. A. McQuarrie, J.D. Simon
34. Modern ElectroChemistry ----- J. O'M. Bockris, A. K. N. Reddy
35. Introduction to solids ----- L. V. Azaroff
36. Elementary crystallography ----- M. J. Buerger
37. Molecular symmetry and group theory ----- Alan Vincent
38. Physical Chemistry of Polymer Solutions - - - - K. Kamide, T. Dobashi
39. Theoretical Chemistry-----S. Glasstone
40. Polymer Science ----- V.R. Gowariker, N. V. Viswanathan, J. Sredhar
41. Introductory Polymer Chemistry ----- G.S. Misra
42. Biophysical chemistry - Debajyoti Das

## Generic Elective papers

### Semester III

**Paper Name: Environmental Chemistry,**

**Paper Code : GE-1A, Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance-5, practical/project-25)**

**Environmental Chemistry (T), Paper Code : GE-1A(T) Credit - 3,**

**FM-75 (ESE -50 + CE- 20 + Attendance-5)**

- A. Geochemistry:** (9 lectures)  
Structure and chemistry of silicate and ore minerals; bulk composition of the earth, crust, & oceans; rock weathering, clay minerals and soil formation; cycling of chemical elements in the earth system.
- B. Chemistry of waters:** (10 lectures)  
properties of water; sources of water and their linkages – hydrologic cycle; concepts of pH, Eh and their variations in waters; metal solubility, complexation and chelation; aquatic life and water chemistry; organic and inorganic including radioactive water pollutants and their removal methods.
- C. Atmospheric Chemistry:** (12 lectures)  
Physical and chemical properties of atmospheric air and their variation with latitude and altitude; chemical reactions in air and the residence time of CO<sub>2</sub> and the greenhouse gases aerosols, their chemistry, sources and transport; organic compounds in air and their sources; physical and health effects of air chemistry changes, global warming and acid rain.
- D. Chemistry of waste substances:** (12 lectures)  
Nature and types of various wastes such as mining, industrial, agricultural, municipal, medical and nuclear; chemical and biological treatment of wastes before disposal; chemistry of toxic inorganic and organic compounds in the environment and their interactions with living system.

**Environmental Chemistry (P),**  
**Paper Code : GE-1A(P) Credit -2, FM-25**

Sample preparation methods: Types & calibration of standards for soil & water analysis. Chemical analysis of water & waste water; Analyses of wastes & solids; Air & gas analysis; Analysis of biological materials. Familiarity with instrumental techniques for basic Chemical analysis: chromatography, spectrophotometer, fluorometry.

**Suggested Readings**

- Manahan, S. E. 2000. Environmental Chemistry 7 th Edn. Lewis Publishers.
- Stumm, W. and Morgan, J.J. 2012. Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters, John Wiley & Sons. Wayne,
- R. P. 2000. Chemistry of Atmospheres: An Introduction to the Chemistry of the Atmospheres of Earth, the Planets, and their Satellites (3rd Ed.), Oxford University Press.
- Williams, I. 2001. Environmental Chemistry –a modular approach, Willey John & Sons Williams.
- R.J.P and Frausto da. J.J.R. 1996. The Natural Selection of the Chemical Elements, Oxford University Press.
- Willard, H.H., Merritt Jr, L.L., Dean, J.A. and Settle Jr, F.A. 1988. Instrumental methods of analysis. 7 th edition. United States: N. P. Web.

**Paper Name : Soil fertility & fertilizer use,**  
**Paper Code : GE-1B, Credit - 5,**  
**FM-100 (ESE -50 + CE- 20 + Attendance-5, practical/project-25)**

**Soil fertility & fertilizer use (T), Paper Code : GE-1B(T) Credit - 3,**  
**FM-75 (ESE -50 + CE- 20 + Attendance-5)**

**A. Soil fertility and soil productivity; nutrient sources –**

fertilizers and manures; essential plant nutrients - functions and deficiency symptoms. Law of soil fertility soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification; biological nitrogen fixation; nitrogenous fertilizers and their fate in soils; management of nitrogenous fertilizers.

**B. Soil and fertilizer phosphorus –**

forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting on availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions. Potassium - forms, equilibrium in soils and its significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions.

### C. Sulphur, Calcium and Magnesium:

source, forms, fertilizers and their behavior in soils; factors affecting their availability in soils; management of fertilizers. Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.

### D. Fertilizer use efficiency;

blanket fertilizer recommendations and limitations; site-specific nutrient management; plant need based nutrient management; integrated nutrient management. Common soil test methods for fertilizer recommendations; quantity– intensity relationships; DRIS, soil test crop response. Soil fertility evaluation, tests; soil quality in relation to sustainable agriculture.

**Paper Name : Soil fertility & fertilizer use (P),**

**Paper Code : GE-1B(P) Credit - 2, FM-25**

#### **Practical**

Estimation of soil phosphate, Sulphate and Nitrate. Flame photometric detection Na & K.

#### **Suggested Books**

- Soil Chemical Analysis (1973) Jackson ML, Prentice Hall
- Soil Productivity and Crop Growth (1966) Raheja PC, Asia Publishing House
- Soil Management in India (1967), Arakeri HR, Asia Publishing House
- Fundamentals of Soil Science (1975) Turk Foth H D, Wiley Eastern University

**Paper Name : Advanced Material**

**Paper Code : GE-1C Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance-5, practical/project-25)**

**Advanced Material (T), Paper Code : GE-1C(T) Credit - 3,**

**FM-75 (ESE -50 + CE- 20 + Attendance-5)**

#### **A. liquid crystals**

(12 lecture)

Mesomorphic behaviour, thermotropic liquid crystals, positional order, bond orientation, order nematic & smectic mesophases, nematic transition & clearing temperature-homotropic, planer & schlieren textures, twisted nematic, chiral nematic, molecular arrangement in smectic A & Smectic B phases, optical properties of liquid crystals, Dielectric susceptibility & dielectric constants, Lyotropic phases & their description or ordering in liquid crystals,

#### **B. Organic/Inorganic supramolecular chemistry:**

(10 lecture)

Basic terms and concepts, nature and types of supramolecular forces, self-assembly of metal atoms/coordination, metal-organic frameworks (MOFs).

- C. Thin films** (10 lecture)  
Thin Films and Langmuir-Blodgett Films, Preparation techniques, vaporation/sputtering, chemical process, MOCVD, sol-gel etc. growth technique, photolithography, properties and applications of thin and L-B films.
- D. Nanotechnology and its applications:** (10 lecture)  
Introduction to nanoscience and technology, terminology and history, optical and semiconducting properties of nanoparticles, metallic nanoparticles, top-down and top-up fabrication, solution based and vapour phase synthesis, synthesis of frameworks, supports and substrates, physical and chemical vapour deposition, artificially layered materials, quantum wells, self-assembled nanostructures, supramolecular chemistry and morphosynthesis, dimensional control; carbon nanotubes, mesoporous materials and metal organic frameworks.
- E. Composites:** (10 lecture)  
introduction to Nanocomposites, Composite material, Mechanical properties of Nano composite material: stress - strain relationship, toughness, strength, plasticity. Synthetic methods for various nanocomposite materials: mechanical alloying, thermal spray synthesis etc. Nano composites for hard coatings; DLC coatings; Polymer nanocomposites; Thin film nanocomposites; Applications of nanocomposites in drug delivery), ionic conductors, molecular devices,
- F. Organic materials:** (5 lecture)  
Chemistry of graphine oxide & Fullerenes: Conducting organics, organic superconductors, magnetism in organic materials. Fullerenes: doped fullerenes as superconductors Fullerenes, ,
- G. Biopolymers** (3 lecture)

**Paper Name : Advance Materials (P),**

**Paper Code : GE-1C(P)**

**Credit - 2, FM-25**

**Practical**

**(30 classes)**

Preparation of gold, silver, iron and zinc nano-material and their characterization by spectroscopy and dynamic light scattering.

**Suggested Books**

- Material science and Engineering, W D Callister, Wiley.
- Solid State Chemistry, A R west.
- Modern Prospective in Solid State Chemistry, C N R Rao and J Gopalakrishnan.
- Principles of Polymer Science, Bahadur P and N.V Shastry, Narosa, New Delhi, 2000. 5. Polymer Science and Engineering, D.J.Williams, Prentice Hall Inc, New Jersey, 1971.
- Theory and Basics of Polymer Science, F.W. Billmeyer, John Wiley & Sons, NY,1984 7.P.M. Ajayan, L.S. Schadler and P.V. Braun, Nanocomposite Science & Technology - WileyVCH GmbH Co. 8. Chatopadhyaya.K.K, and Banerjee A.N, Introduction to Nanoscience and Nanotechnology
- C.N.R. Rao, A. Muller and A.K. Cheetham, The Chemistry of nanomaterials: Synthesis, Properties and Applications, Vol-I
- New direction in solid state chemistry C N R Rao and J Gopalakrishnan, 2<sup>nd</sup> Ed, Cambridge University Press

## **Generic Elective Papers**

### **Semester - IV**

#### **GE 2**

**Paper Name : Biomolecules and their Biochemistry,**

**Paper Code : GE-2A Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance-5, practical/project-25)**

**Biomolecules and their Biochemistry (T), Paper Code : GE-2A(T) Credit - 3,**

**FM-75 (ESE -50 + CE- 20 + Attendance-5)**

#### **A. Carbohydrate:**

**(8 lectures)**

Classification, structure, general properties and functions of polysaccharides and complex carbohydrates; amino sugars, proteoglycans and glycoproteins.

#### **B. Lipids**

**(10 lectures)**

Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrocides, steroids, bile acids, prostaglandins, lipoamino acids, lipoproteins, proteolipids, phosphatidopeptides, lipopolysaccharides.

#### **C. Proteins:**

**(12 lectures)**

Peptide synthesis: chemical and Merrifield synthesis. Primary (peptide conformation, N- and C- terminal, peptide cleavage), Secondary ( $\alpha$ -helix, sheet, random coil, Ramachandran plot), Tertiary and Quaternary structures of proteins. Cell free protein expression.

#### **D. Enzymes**

**(10 lectures)**

Historical perspective, general characteristics, nomenclature, IUB enzyme classification (specific examples), measurement and expression of enzyme activity, enzyme assay. Definitions of IU, Katal, enzyme turnover and specific activity. Methods for isolation, purification and characterization of enzymes, tests for homogeneity of enzyme preparation.

#### **E. Nucleic acids**

**(10 lectures)**

Nucleic acids as genetic information carriers, experimental evidence e.g., genetic transformation, Hershey-Chase experiments, action spectrum, etc. Structure and function of nucleotides. Primary, secondary and tertiary structure of nucleic acids, DNA forms and conformations, Denaturation of DNA.

#### **F. Chemistry of toxins**

**(3 lectures)**

Classification, structure and mode of action of bacterial protein toxins.

**Paper Name : Biomolecules and their Biochemistry (practical)**

**Paper Code : GE-2A(P) Credit - 2, FM-25**

**Practical**

**(30 classes)**

Detection and estimation of glucose, protein and lipid in their natural sources.

### **Suggested Books**

- Biochemistry (2011) D. Voet and J.G. Voet, pub. Wiley.
- Biochemistry” (2015) J.M. Berg, J.L. Tymoczko and L. Stryer, pub. W.H. Freeman
- Molecular Cell Biology (2012) H. Lodish, et al, pub. W.H. Freeman.
- Molecular Biology of the Cell” (2014) B. Alberts et al., pub. Garland.
- Practical Skills in Biomolecular Sciences” (2012) R. Reed, D. Holmes, J. Weyers and A. Jones, pub. Prentice Hall.
- Principles and problems in physical chemistry for biochemists (2001) N.C. Price, R.A. Dwek, R.G. Ratcliffe and M.R. Wormald, pub. Oxford University Press.

### **Paper Name : Medicinal Chemistry**

**Paper Code : GE-2B Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance-5, practical/project-25)**

**Medicinal Chemistry (T), Paper Code : GE-2B(T) Credit - 3,**

**FM-75 (ESE -50 + CE- 20 + Attendance-5)**

**A. Molecular Recognition in Drug-Receptor Binding Molecular forces, Binding energetics**

**B. Enzyme Inhibitors:** Modes of inhibition, General approaches.

**C. Important Drugs:**

- i. Antibacterial Drugs: Major drug classes, Drug resistance
- ii. Antiviral Drugs i. Description of viruses ii. Major drug classes iii. Drug resistance
- iii. Anticancer Drugs, Major cancer drug targets, MOA of anticancer drugs, Drug resistance
- iv. Analgesic Drugs
- v. anesthetics (general, local)
- vi. Neurotransmitters (adrenergic, cholinergic effects; psychopharmacology)
- vii. CNS depressants (sedative/hypnotic, major/minor tranquilizers), CNS stimulants
- viii. Steroids

**D. Drug Metabolism:** Phase I metabolism, Phase II metabolism

**E. Prodrug Design:** Bioprecursor prodrugs, Carrier-linked prodrugs

**Medicinal Chemistry (P), Paper Code : GE-2B(P) Credit - 2,**

**FM-75 (ESE -50 + CE- 20 + Attendance-5)**

**Practical:** same as Biomolecules and their Biochemistry:

### **Suggested Books:**

- Principles Of Medicinal Chemistry Drug Design , Deniz Ekinci
- An Introduction to Medicinal Chemistry, Graham L Patrick
- Textbook of Medicinal Chemistry, V.Alagarsamy

**Paper Name : Environmental Pollution and Health,**

**Paper Code : GE-2C Credit - 5,**

**FM-100 (ESE -50 + CE- 20 + Attendance-5, practical/project-25)**

**Environmental Pollution and Health (T), Paper Code : GE-2C(T) Credit - 3,**

**FM-75 (ESE -50 + CE- 20 + Attendance-5)**

**A. Water resources and its pollution**

Water sources, quality and standards. Water purification and surveillance of drinking water quality. Infections and diseases spread by contaminated water.

**B. Air pollution:**

composition and sources. Air quality monitoring. National and international standards for monitoring air quality. Diseases caused by air pollution. Quality of indoor air and its effect on health. Ventilation: standards, methods and health hazards.

**C. Radiation pollution:**

sources, biological effects and protection. Meteorological environment monitoring. Air temperature and biological effects.

**D. Noise pollution:**

source and standards. Noise pollution: health hazard and protective measures. Housing standards and effect on health. Methods of disposal of solid waste. Diseases related to soil pollution. Problems and methods of excreta disposal. Arthropods of medical importance.

**E. Vector-borne diseases:**

transmission and control. Impact of fleas, ticks and mites on health. Zoonotic diseases and their prevention and control. Hospital environment in the context of health and disease.

**F. Pollution control in India:**

Government obligation, mechanism and legislation in the context of public health.

**Environmental Pollution and Health (P),**

**Paper Code : GE-2C(P) Credit - 2, FM-25**

**Practical:** Field Study on the pollution and effect on health.

**Suggested Books**

- Holgate, S.T., Koren, H.S., Samet, J.M. and Maynard, R.L. eds. 1999. Air pollution and health. Elsevier.
- McGranahan, G. and Murray, F., 2012. Air pollution and health in rapidly developing countries. Earthscan.
- Murray J.F. and Nadel. J.A. 2000. Text book of respiratory medicine, 3rd Edn. W.B. Saunders & Co.
- Partdos, C.D., Ignatius, R. and Schneider, T. 2005. Topley and Wilson's microbiology and microbial infections. Oxford University Press.
- Park. J.E. and Park. K. 1994. Text book of preventive and social medicine, Banarsi Das & Bhanot, Jabalpur.
- Smith, K.R. 2013. Biofuels, air pollution, and health: a global review. Springer Science & Business Media.