

**Dept. of Chemistry Syllabus**  
**For**  
**M.Sc. in Chemistry**  
**Panskura Banamali College**  
**(Autonomous college under**  
**Vidyasagar University)**  
**MIDNAPORE (EAST), WEST BENGAL.**

## PROGRAM OUTCOME

Education in India is mostly based on the foundation for understanding and realization of the specific subject. A society can achieve a pioneering model of education in the universe through a blending of theory and practical knowledge. Rationalization and interpretation of the natural phenomena through the model subject are accounted for by chemical science. The theories have contributed most to the understanding of the subject chemistry and qualitative models of bonding and reactivity clarify and systematize the subject. The ultimate authority consists of observations and measurements, such as identities of the product(s) of a reaction, structure, thermodynamic properties, spectroscopic signature, and measurement of reaction rates. The program outcome of the Master's in chemistry help the student to be a global researcher with a huge outlook on building a career in chemistry.

The program outcome mainly concentrated on the following agenda:

- ❖ Vertical progression in the specialized interdisciplinary subjects in the academic career like Post M. Sc and Ph. D in overseas and in India.
- ❖ Eligible professions in Teaching, Industries like Chemistry, Medicine, Pharmaceutical, Agricultural Chemistry, Oil industries, Biochemical, Mineral, Hydroelectric, Paint and Dyes industries, etc.
- ❖ Global leaders with profound outlook and trustworthiness convert the top achievers like scientists, industrialists, and international scholars.

**Table 1: PAPER/CREDIT/FULL MARKS OF COURSE**

Semester	Paper	No of Paper	Full marks on each paper	Credit point of each paper	Total marks	Credit point	Total credit point
SEM I	THEORY	4	50	4	200	16	24
	PRACTICAL	2	50	4	100	8	
SEM II	THEORY	4	50	4	200	16	24
	PRACTICAL	2	50	4	100	8	
SEM III	THEORY	4	50	4	200	16	24
	PROJECT	1	100	8	100	8	
SEM IV	THEORY	4	50	4	200	16	24
	PROJECT	1	100	8	100	8	

**Table 2: SPECIAL PAPER WISE COURSE STRUCTURE AND CONTENTS**

SEMESTER	COURSE NO	COURSE TITLES	UNIT CONTENTS	FULL MARKS	CREDIT
SEM I	CEM 101	PHYSICAL CHEMISTRY I	<ul style="list-style-type: none"> <li>✓ Mathematical preliminaries &amp; Quantum Mechanics-I</li> <li>✓ Statistical Thermodynamics and Mechanics</li> <li>✓ Electrochemistry</li> <li>✓ Principles of molecular spectroscopy-I</li> </ul>	50	4

	CEM 102	<b>ORGANIC CHEMISTRY</b>	<ul style="list-style-type: none"> <li>✓ Pericyclic reaction-1</li> <li>✓ Organic transformations / synthesis / reagents</li> <li>✓ Natural products- terpenoids &amp; Natural products-alkaloids</li> </ul>	50	4
	CEM 103	<b>INORGANIC CHEMISTRY</b>	<ul style="list-style-type: none"> <li>✓ Symmetry group theory -1</li> <li>✓ Crystallography</li> <li>✓ Bioinorganic chemistry-1</li> <li>✓ Chemical Toxicology</li> </ul>	50	4
	CEM104	<b>FOOD PROCESSING AND PRESERVATION AND PHARMACEUTICAL CHEMISTRY</b>	<ul style="list-style-type: none"> <li>✓ Constituents of food</li> <li>✓ Introduction to food microbiology</li> <li>✓ Food preservation</li> <li>✓ Introduction of pharmaceutical chemistry</li> <li>✓ Classification and nomenclatures of drugs</li> <li>✓ Theory of drug action and factors affecting the drugs</li> <li>✓ Types of drugs</li> </ul>	50	4
	CEM 105	<b>INORGANIC PRACTICAL</b>	<ul style="list-style-type: none"> <li>✓ Quantitative analysis</li> <li>✓ Analysis of metals and alloys</li> <li>✓ Analysis of ores and minerals</li> <li>✓ Equilibrium studies on inorganic reactions</li> <li>✓ Spectrophotometric estimation</li> <li>✓ Synthesis and characterization of inorganic compounds</li> </ul>	50	4
	CEM 106	<b>FOOD AND PHARMACEUTICAL LAB</b>	Experiments	50	4
<b>SEM II</b>	CEM 201	<b>PHYSICAL CHEMISTRY II</b>	<ul style="list-style-type: none"> <li>✓ Quantum mechanics –II</li> <li>✓ Chemical kinetics</li> <li>✓ Electrochemistry –II</li> <li>✓ Molecular spectroscopy -II</li> </ul>	50	4

	CEM 202	<b>ORGANIC CHEMISTRY II</b>	<ul style="list-style-type: none"> <li>✓ Pericyclic reaction –II</li> <li>✓ Organic transformation/ reagent chemistry/synthesis – II</li> <li>✓ Retrosynthetic analysis-II</li> <li>✓ Stereochemistry-1</li> <li>✓ Stereochemistry-2</li> </ul>	50	4
	CEM 203	<b>INORGANIC CHEMISTRY II</b>	<ul style="list-style-type: none"> <li>✓ Organometallic chemistry-I</li> <li>✓ Allotrops of carbon and boron compounds</li> <li>✓ Group theory –II</li> <li>✓ Chemistry of d-block elements</li> </ul>	50	4
	CEM 204	<b>NANOTECHNOLOGY: PRINCIPLES AND PRACTICALS</b>	<ul style="list-style-type: none"> <li>✓ Introduction</li> <li>✓ Synthesis of nanomaterials</li> <li>✓ Analysis techniques</li> <li>✓ Application of nanotechnology</li> </ul>	50	4
	CEM 205	<b>PHYSICAL PRACTICALS II</b>	<ul style="list-style-type: none"> <li>✓ List of experiments</li> <li>✓ Sessional Work</li> <li>✓ Viva voce</li> </ul>	50	4
	CEM 206	<b>ORGANIC PRACTICALS II</b>	<ul style="list-style-type: none"> <li>✓ Liquid sample</li> <li>✓ Extraction of renewable chemicals               <ul style="list-style-type: none"> <li>○ OR</li> </ul> </li> <li>✓ Preparation</li> <li>✓ Sessional work</li> <li>✓ Viva voce</li> </ul>	50	4
<b>SEM III</b>	CEM 301	<b>PHYSICAL CHEMISTRY SPECIAL I</b>	<ul style="list-style-type: none"> <li>✓ Approximate method in QM -I</li> <li>✓ Approximate method in QM –II</li> <li>✓ Group theory-I</li> <li>✓ Group theory -II</li> </ul>	50	4

CEM 302	<b>PHYSICAL CHEMISTRY SPECIAL II</b>	<ul style="list-style-type: none"> <li>✓ Statistical mechanics-II</li> <li>✓ Chemical kinetics –I</li> <li>✓ Chemical kinetics –II</li> <li>✓ Advance electrochemistry</li> </ul>	50	4	
CEM 301	<b>INORGANIC CHEMISTRY SPECIAL I</b>	<ul style="list-style-type: none"> <li>✓ Organometallic chemistry-II</li> <li>✓ Application of organometallic chemistry and catalysis</li> <li>✓ Chemical applications of group theory</li> <li>✓ Chemistry of f-block elements</li> </ul>	50	4	
CEM 302	<b>INORGANIC CHEMISTRY SPECIAL II</b>	<ul style="list-style-type: none"> <li>✓ Bioinorganic chemistry-II</li> <li>✓ Nuclear chemistry-II</li> <li>✓ Inorganic photochemistry</li> <li>✓ Solid state chemistry</li> </ul>	50	4	
CEM 301	<b>ORGANIC CHEMISTRY SPECIAL I</b>	<ul style="list-style-type: none"> <li>✓ Pericyclic reaction-3</li> <li>✓ Linear free energy relationship-I</li> <li>✓ Linear free energy relationship-II</li> <li>✓ Organometallic Chemistry</li> </ul>	50	4	
CEM 302	<b>ORGANIC CHEMISTRY SPECIAL II</b>	<ul style="list-style-type: none"> <li>✓ Bioorganic and supramolecular chemistry-I</li> <li>✓ Bioorganic and supramolecular chemistry-II</li> <li>✓ Bioorganic and supramolecular chemistry-III</li> <li>✓ Peptides and nucleic acids</li> <li>✓ Green chemistry</li> </ul>	50	4	

	CEM 303	SPECTROSCOPY FUNDAMENTAL	<ul style="list-style-type: none"> <li>✓ Photophysical process</li> <li>✓ Laser and its applications</li> <li>✓ EPR spectroscopy</li> <li>✓ PES and NQR spectroscopy</li> </ul>	50	4
			✓		
	CEM 304	PHARMACEUTICAL CHEMISTRY	<ul style="list-style-type: none"> <li>✓ Introduction of pharmaceutical chemistry</li> <li>✓ Classification and nomenclatures of drugs</li> <li>✓ Theory of drug action and factors affecting the drugs</li> <li>✓ Types of drugs Antimalarial drugs</li> </ul>	50	4
	CEM 305	PROJECT (PHYSICAL SPECIAL/ORGANIC SPECIAL/INORGANIC SPECIAL)	Industry visit  OR  Research work	100	8
SEM IV	CEM 401	PHYSICAL CHEMISTRY SPECIAL III	<ul style="list-style-type: none"> <li>✓ Quantum mechanics of many-electron atoms</li> <li>✓ Atomic spectroscopy</li> <li>✓ QM of diatomic molecules</li> <li>✓ QM of polyatomic molecules</li> </ul>	50	4
	CEM 402	PHYSICAL CHEMISTRY SPECIAL IV	<ul style="list-style-type: none"> <li>✓ Non-equilibrium thermodynamics</li> <li>✓ Macromolecular and Biopolymers</li> <li>✓ Solid-state –I</li> <li>✓ Solid-state –II</li> </ul>	50	4
	CEM 401	INORGANIC CHEMISTRY SPECIAL III	<ul style="list-style-type: none"> <li>✓ Magneto chemistry-I</li> <li>✓ Magneto chemistry –II</li> <li>✓ Metal carbonyls, clusters and metal-metal bonded compounds</li> <li>✓ Supramolecular chemistry and designing of molecular materials</li> </ul>	50	4

CEM 402	<b>INORGANIC CHEMISTRY SPECIAL 1V</b>	<ul style="list-style-type: none"> <li>✓ Reaction mechanism of transition metal complexes</li> <li>✓ Electron transfer reactions and twist mechanism</li> <li>✓ Analytical Chemistry –I</li> <li>✓ Analytical Chemistry -II</li> </ul>	50	4
CEM 401	<b>ORGANIC CHEMISTRY SPECIAL 1III</b>	<ul style="list-style-type: none"> <li>✓ Organic photochemistry-I</li> <li>✓ Organic photochemistry-II</li> <li>✓ Biological active molecules</li> <li>✓ Vitamins and co-enzymes</li> <li>✓ Heterocycles-2</li> </ul>	50	4
CEM402	<b>ORGANIC CHEMISTRY SPECIAL 1V</b>	<ul style="list-style-type: none"> <li>✓ Stereochemistry -3</li> <li>✓ Stereochemistry-4</li> <li>✓ Stereochemistry-5</li> <li>✓ Stereochemistry-6</li> <li>✓ Stereochemistry-7</li> </ul>	50	4
CEM403	<b>SPECTROSCOPY AND STRUCTURE ELUCIDATION</b>			
CEM 404	<b>FOOD PROCESSING AND PRESERVATION AND NANO SCIENCE (COMMON PAPER )</b>	<ul style="list-style-type: none"> <li>✓ Milk products</li> <li>✓ Cereals legumes and nuts</li> <li>✓ Fats and oils</li> <li>✓ Food safety</li> <li>✓ Fruits and vegetables</li> </ul>	50	4
CEM 405	<b>PROJECT (PHYSICAL SPECIAL/ORGANIC SPECIAL/INORGANIC SPECIAL)</b>	Research work (extension from semester-III)	100	8



## SEMESTER-I

**PAPER: CEM-101 (PHYSICAL CHEMISTRY I): MARKS 50, CREDIT 4 CLASSES 45**

### COURSE OUTCOME

The students will learn the basics of Quantum Mechanics, Statistical Thermodynamics, Fundamentals of Electrochemistry and Molecular Spectroscopy.

**Unit 1: Mathematical Preliminaries & Quantum Mechanics-I:** Elements of Calculus, Extremum Principles, Constrained Extremization, powerer Series, Fourier transformation, Vectors and vector space, Differential equations. Postulates and their analysis, Properties of Operators and Commutators, angular momentum operator, Equation of Motion, Stationary States, Ehrenfest's Theorems, Barrier problems.

**Unit 2: Statistical Thermodynamics and Mechanics:** Thermodynamic equation of state, Partial molar quantities, thermodynamics of mixing, activity and fugacity-applications in real systems, Nernst heat theorem, third law of thermodynamics, Phase cell, macrostate, microstate, thermodynamical probability and entropy, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Partition functions of diatoms (translational, rotational, vibrational and electronic).

**Unit 3: Electrochemistry-I:** Debye Huckel theory, its modifications and extensions, mean ionic activity co-efficients, ion association, and precise determination of dissociation constants of weak electrolytes by method of emf and conductance measurements, ion-solvent interaction and solvation number.

**Unit 4: Principle of Molecular Spectroscopy-I:** General introduction, nature of electromagnetic radiation, shapes & width of spectral lines, Intensity of spectral lines, Fourier transform. Microwave Spectroscopy: Moment of Inertia and Classification of molecules, Diatomic molecule as rigid rotator, non-rigid rotator, Hyperfine Structures, Stark Effect and determination of Dipole moment. Infrared Spectroscopy: Vibrational Spectra of diatomic Molecules, Harmonic Oscillator model, Anhermonic oscillator model, Rotational Vibrational spectra of diatomic molecules.

**PAPER CEM 102 (ORGANIC CHEMISTRY): MARKS 50, CREDIT 4 CLASSES 45**

**COURSE OUTCOME**

**Knowledge gathering and learning of Organic Chemistry topics like pericyclic reaction, various organic transformations, terpenoids, and Alkaloids.**

**Unit 01: Pericyclic reaction 1:** Pericyclic reactions characteristic features, conservation of orbital symmetry MO of different polyenes, electrocyclic, cycloaddition, sigmatropic reactions, Rationalisation of different examples with the basis of frontier orbital interaction, Woodward-Hoffmann symmetry rules for pericyclic reactions, exceptions to symmetry rules, correlation diagram of different pericyclic reactions. Problems relating to these reactions.

**Unit 02: Organic transformations/Reagent Chemistry/Synthesis-I:** Cation-olefin cyclization reaction: application to the synthesis of triterpenes: biogenetic isoprene rule: monocyclic, bicyclic, tricyclic, tetracyclic, and pentacyclic ring systems. Fragmentation reaction, Remote functionalization: biomimetic reactions / template effect, examples. Functional groups interconversion. Multicomponent reactions: Definition, early examples, Passerine reaction, Ugi reaction. Olefin metathesis reaction: Definition, Ring-closing metathesis reaction, examples. Phase transfer catalysis.

**Unit 03: Natural products-Terpenoids:** Terpenoids: Isoprene rules, acyclic monoterpenoids, central geraniol, neral, linalool monocyclic monoterpenoids; -terpeninol, structure elucidation, synthesis and biogenesis. Higher terpenoids: sesqui-, di-, sester-, tri-, tetra- terpenoids.

**Unit 04: Natural Products - Alkaloids:** Alkaloids: Phenyl ethyl amine, quinine, nicotine, peptides, nucleoside and nucleotide structure, synthesis, biogenesis.

**Unit 05: Retrosynthetic analysis-I:** Organic Synthesis Strategy, the disconnection approach.

**PAPER CEM 103 (INORGANIC CHEMISTRY): MARKS 50, CREDIT 4 CLASSES 45****COURSE OUTCOME**

Students will understand the topic of Symmetry and Group Theory 1, Crystallography, Bioinorganic Chemistry, and Chemical Toxicology

**Unit: 1 Symmetry and Group theory-I**

Groups and their properties- the concept of groups; subgroups, classes and the related theorems; commutative (abelian) groups and cyclic groups and their examples; group multiplication tables and the rearrangement theorem. Symmetry elements and operations, products of symmetry operations, equivalent symmetry elements and equivalent atoms, symmetry in platonic solids, identification of point groups, Symmetry of C<sub>60</sub> fullerenes, Crystallographic symmetry: 32 crystal classes, Hermann–Mauguin (HM) notations, optical activity and dipole-moment on the basis of point group symmetry; similarity transformation and the invariance of characters; block diagonalisation; direct product of matrices and their characters, etc. Matrix representation of symmetry operations, characters of symmetry operations in a representation, invariance of character under similarity transformation, the row/column orthogonality of characters, reducible and irreducible representations, the “Great Orthogonality Theorem” (without derivation) and its corollaries.

**Unit: 2 Crystallography** Crystalline solid: single crystal and polycrystal (twinning problem) lattice, unit cell-primitive and non-primitive unit cells, unit cell parameters and crystal systems. Space group- Hermann–Mauguin notations, space group in triclinic and monoclinic system. Indexing of lattice planes, Miller indices. Bragg’s equation, reciprocal lattice and its relation to direct lattice; Bragg’s reflection in terms of reciprocal lattice-sphere of reflection and limiting sphere; the relation between  $d_{hkl}$  and lattice parameters.

**Unit: 3 Bioinorganic Chemistry-I** Essential elements in Biology (major and trace), beneficial and toxic elements, role of metal ions. Bioenergetic principle and role of ATP. O<sub>2</sub> – uptake proteins: hemoglobin, myoglobin, hemerythrin and hemocyanin, structure, function, and model study. Electron transport protein: Fe-S proteins, cytochromes. Metal ions transport and storage proteins: ferritin, transferrin, ceruloplasmin. Transport across biological membrane - Na<sup>+</sup>-K<sup>+</sup>-ATPase, ionophores. Hydrolytic enzymes: carbonic anhydrase, carboxypeptidase, urease. Metal dependent diseases: Wilson's disease, Alzheimer's disease. Transition metal complexes as drugs.

**Unit: 4 Chemical Toxicology** Trace elements and their chemical speciation with special reference to Cu, Zn, Cd, Hg, Pb, Ag, Sb, Se, Ti, Si, Be etc. Toxic chemical in air, water, soil, diet, fertilizer, their effects and remedial measures. Metal ion toxicity, metal dependent diseases, remedial measures, Bio-mineralogy.

**PAPER CEM-104 (FOOD PROCESSING AND PRESERVATION AND PHARMACEUTICAL CHEMISTRY): MARKS 50, CREDIT 4, LECTURES 45**

**COURSE OUTCOME**

The students will gain an understanding of the topics of food processing and preservation, Food microbiology, and food preservation. The fundamentals of pharmaceutical chemistry and the various drugs and their constituents are also the outcomes of the course.

**GROUP-A FOOD PROCESSING AND PRESERVATION, MARKS 20, CREDITS 04, CLASSES (45).**

**UNIT-01: Constituents of Food:** Water, carbohydrates, Lipids, Proteins, Vitamins and Minerals; Mineral water: natural and with added minerals. (8 Lectures)

**UNIT-02: Introduction to food microbiology**, Factors influencing microbial activity, Food spoilage, Types and causes of food spoilage. (8 Lectures)

**UNIT-03: Food preservation:** Principles and methods; Drying, Refrigeration, Freezing, chemical additives, evaporation, Fermentation. (8 Lectures)

**Group-B PHARMACEUTICAL CHEMISTRY                      F.M.-30**

**1. Introduction of Pharmaceutical Chemistry**

Important aspects of pharmaceutical chemistry, importance of chemistry in pharmaceuticals, some important terms used in chemistry of drugs, pharmacopeia.

**2. Classification and nomenclatures of drugs**

Classification of drugs and their nomenclature.

**3. Theory of drug action and factors affecting the drugs**

Theory of drug action and structure-activity relation, drug receptors: isolation, modification, and localization, theories related to drug action.

**4. Types of drugs**

A. Hypnotics and sedative drugs, Anticonvulsivant and analgesic drugs, general anesthetics and local anesthetics, expectorant, psychoactive and nervous system stimulant drugs, antiparkinson, antihistamine, anti-inflammatory, and antipyretic drugs.

B. Antiamoebic, antifungal and antiviral drugs, antineoplastic agents, disinfectant and antiseptic, thyroid hormones and antithyroid drugs, Vitamins, sulfonamides, and antibiotics.

**Text Books/References:**

1. Food Science, 5th Ed, 1997, B. Srilakshmi, New Age International (P) Ltd, New Delhi.
2. N.N. Potter CBS Publishers and Distributors, Delhi, 5th Ed, 1996 Food Science.
3. Food Processing and Preservation by B. Sivasankar.

**SEM-I****CEM 105: Inorganic Chemistry Practical****1. Quantitative analysis**

- 1A. Gravimetric estimation of Zn(II) as  $\text{Zn}(\text{NH}_4)(\text{PO}_4)$
- 1B. Gravimetric estimation of Cu(II) as  $\text{CuSCN}$
- 1C. Gravimetric estimation of Ni(II) as  $\text{Ni}(\text{DMGH})_2$
- 1D. Gravimetric estimation of Ba(II) as  $\text{BaSO}_4$
- 1E. Gravimetric estimation of Pb(II) as  $(\text{Pb})_3(\text{PO}_4)_2$
- 1F. Volumetric estimation of Mn(II)/Fe(III)
- 1G. Volumetric estimation of Cr(VI)/ Fe(III)
- 1H. Volumetric estimation of Cu(II)/ Fe(III)
- 1I. Volumetric estimation of Cu(II)/Cr(VI)

**2. Analysis of Metals and Alloys**

- 2A. Quantitative estimation of Zn(II) and Cu(II) in the brass sample by volumetry and gravimetry
- 2B. Quantitative estimation of iron in cast iron and steel.

**3. Analysis of Ores and Minerals**

- 3A. Quantitative estimation of manganese in pyrolusite
- 3B. Quantitative estimation of  $\text{CaCO}_3$  and  $\text{CaCO}_3$  in dolomite

**4. Equilibrium studies on inorganic reactions**

- 4A. Determination of the composition of Fe(III)-sulfosalicylate complex in solution by Mole-Ratio method.
- 4B. Determination of the composition of Fe(II)-1,10-phenanthroline complex in solution by Mole-Ratio method.

4C. Determination of the composition of Fe(III)-sulfosalicylate complex in solution by Slope-Ratio method.

4D. Determination of the composition of Fe(II)-1,10-phenanthroline complex in solution by Slope-Ratio method.

4E. Determination of the composition of Fe(III)-sulfosalicylate complex in solution by Job's method of continuous variation.

4F. Determination of the composition of Fe(II)-1,10-phenanthroline complex in solution by Job's method of continuous variation.

### 5. Spectrophotometric Estimation

5A. Colourimetric estimation of Fe(III) (as thiocyanate complex) 5B. Colourimetric estimation of Fe(II) and Fe(III) in a mixture as Fe(II)-1,10-phenanthroline complex.

### 6. Synthesis and Characterization of inorganic compounds

6A. Reinkey's salt

6B.  $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$

6C.  $[\text{Cu}(\text{NH}_3)_4(\text{SO}_4)(\text{H}_2\text{O})]$

6D.  $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$

6E.  $[\text{Ni}(\text{en})_2]\text{Cl}_2$

6F.  $\text{K}_3[\text{Fe}(\text{ox})_3]$

6G.  $\text{K}_3[\text{Cr}(\text{ox})_3]$

6H.  $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$

6I.  $[\text{Cu}(\text{NH}_3)_4(\text{SO}_4)(\text{H}_2\text{O})]$

6J. Crome alum  $[\text{K}_2\text{SO}_4, \text{Cr}_2(\text{SO}_4)_3, 24\text{H}_2\text{O}]$ .

**CEM 106 (FOOD AND PHARMACEUTICAL LAB) : MARKS 50, CREDIT 4, LECTURES 45.**

**EXPERIMENTS**

I: Preparation of jams, jellies, syrups, squashes,

II: Preparation of mixed fruit juices: Aloe vera mixed with lichi, mango, pineapple, watermelon, etc.

III: Estimation of Food Values (carbohydrate, fat, protein, vitamins) and Food Safety

Test. IV: Preservation of processed food V: Packaging of processed and preserved food

**EXPERIMENTS II: Synthesis and analysis of drugs-**

a) Ibuprofen, b) Paracetamol and c) Chloramphenicol

**REFERENCES** 1. Rahman, M.S. "Handbook of Food Preservation", Marcel Dekker, 1999.

2. Ranganna, S. "Handbook of Canning and Aseptic Packaging" Vol. I, II & III, Tata McGraw – Hill, 2000.



## SEMESTER II

**PAPER CEM 201 (PHYSICAL CHEMISTRY II): MARKS 50, CREDIT 4, LECTURES 45**

### COURSE OUTCOME

The students will learn the advanced course in Quantum Mechanics, Statistical Thermodynamics, Fundamentals of Electrochemistry and Molecular Spectroscopy.

**Unit-1: Quantum Mechanics-II** Bound States, Box with infinite and finite walls. Harmonic Oscillator (Wave function and Operator methods), Hydrogen atom Problem: Cartesian and Polar coordinates. Centre of Mass and relative coordinate, Spherical harmonics. Real and complex orbital, Role of constant of motion.

**Unit-2: Chemical Kinetics** Flow and relaxation methods of measurements of reaction rates, flash photolysis, Kinetics of fast reaction, Homogeneous and heterogeneous catalysis, Enzyme catalysis and inhibition, autocatalysis, oscillatory reactions (general introduction only), redox reactions, Preliminary idea of Transition State Theory.

**Unit-3: Electrochemistry-II** Non stationary processes in electrolytic solutions, Onsager conductance equation, effect of high electric field and frequency on ion conductance, overvoltage, polarography, amperometric titration, basic principles of cyclic voltammetry and coulometry, polyelectrolyte.

**Unit-4: Molecular Spectroscopy-II** Raman Spectroscopy: Introduction. Classical Theory of Raman Scattering, Q.M Picture of Raman Scattering, Characteristic parameters of Raman lines, Pure Rotation and Vibrational Raman spectra, Basic Principles of a Raman spectrometer, Application of Raman Spectroscopy. Electronic Spectroscopy: Fluorescence, Phosphorescence and nonradiative processes.

### Sem-II

**PAPER CEM 202 (ORGANIC CHEMISTRY) : MARKS 50, CREDIT 4, CLASSES 45)**

### COURSE OUTCOME

Advanced knowledge gathering and learning of Organic Chemistry topics like pericyclic reaction, various organic transformations, Retrosynthesis, and basics of stereochemistry.

**Unit 01: Pericyclic reaction 2:** Perturbation molecular orbital theory (PMO), energy diagram of ethylene and butadiene system with different substitutions and study of their cycloaddition reactions, orbital coefficient and diagram of polyene systems with various

substitutions. Regioselectivity, Periselectivity and Site selectivity, secondary interactions in pericyclic reactions, cheletropic reactions. Problems relating to these reactions.

**Unit 02: Organic transformations/ Reagent Chemistry/Synthesis-II:** Oxidations reactions: Hydroxylation reagents, use of peroxy acids, Woodward prevost hydroxylation, Sharpness asymmetric epoxidation, AD-mix, Transformation of epoxides. Organophosphorus reagents, organo sulfur reagents, organo boranes, organo silanes, organostannanes, metal hydrides, Birch reduction, Bayer Villiger reactions, chichibabin reaction, Merrifield resin: solid phase synthesis.

**Unit 03: Retro synthetic analysis-II:** Retro synthetic analysis-II: disconnection approach. Examples to illustrate disconnection approach in organic synthesis.

**Unit 04: Stereochemistry 1:** 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. Stereochemical features : cyclohexane and its derivatives conformation and physical properties. Computation of stereoisomers of different systems. Conformation and relative reactivity of diastereomers. 2-, 3-, and 4- Alkyl ketone effects.

**Unit 05: Stereochemistry 2 :** Prochirality and Prostereoisomerism. Topicity and Reactivity. A symmetric synthesis : Addition of a chiral reagents to chiral ketones and aldehydes, models of stereochemical control : Cram, Felkin and Karabatsos. Atropisomerism Molecular rearrangements with Neighbouring group participations. Stereospecific and stereoselective reactions. Sharpless epoxidation.

## Sem-II

**PAPER CEM 203 (INORGANIC CHEMISTRY) : MARKS 50, CREDIT 4, CLASS 45**

### COURSE OUTCOME

Students can learn about organometallic chemistry, allotropes of carbon/boron, d-block elements, and advanced course in group theory.

**Unit: 1 Organometallic chemistry –I** Application of 18-electron and 16-electron rules to transition metal organometallic complexes, Ligands in organometallic chemistry; Synthesis, bonding and reactivity of Metal-alkyl, -alkene, -alkyne, -allyl, -carbene, -carbyne and -carbide complexes, Agostic interaction, Stereochemical non-rigidity and fluxional behaviour of organometallic compounds with typical examples.

**Unit: 2 Allotropes of carbon and boron compounds** Allotropes of Carbon: C<sub>60</sub> and compounds (fullerenes), Intercalation compounds of Graphite, Carbon nanotubes, synthesis, properties, structure-single walled, multi-walled, applications, Graphene. Boron cluster classification, skeletal electron counting. Boron hydrides: boranes, structure, bonding (MO description of B<sub>2</sub>H<sub>6</sub> and B<sub>2</sub>H<sub>6</sub><sup>2-</sup>) and Lipscomb's topology, „styx“ system of numbering, nomenclature; carboranes, metalloboranes, metallocarboranes-synthesis and structure; Wade's rules, boron compounds of potential medicinal interest; boron neutron capture theory (BNCT).

**Unit: 3 Group theory-II** Character tables (C<sub>2v</sub>, C<sub>3v</sub>, C<sub>4v</sub>, D<sub>4</sub>), representation for cyclic groups, wave functions as bases for Irreducible Representations, the standard reduction formula; the direct product representation and its decomposition, identifying nonzero matrix elements, spectral transition probabilities, allowedness-forbiddenness of n-π\* and π-π\* transitions, symmetry of normal modes, normal mode analysis, selection rules for IR and Raman transitions. Projection operator (without derivation), use of the projection operator to form symmetry adapted linear combination (SALC) of a simple system.

**Unit: 4 Chemistry of d-block elements** Chemistry of Ti -Zr- Hf, V-Nb-Ta, Cr-Mo- W, Mn-Tc-Re, Ru-Rh-Pd, Os-Ir-Pt with reference to electronic configuration, oxidation states, coordination number, aqueous chemistry, redox behavior. Iso- and heteropolyoxometalates with respect of V, Mo and W: synthesis, reactions, structures, uses. Dinitrogen and dioxygen complexes: synthesis, structure, bonding and reactivity. Bonding and properties of molybdenum blue, tungsten blue, ruthenium blue, platinum blue, tungsten bronze, ruthenium red. Creutz-Taube complex, Vaska's complex. Nb, Ta halide clusters. Electronic configuration, oxidation state and comparative study Stabilization of uncommon oxidation states of transition metals by complex formation -Fe(IV), Co(IV), Ni(III), Ru(IV), Os(IV), Pd(III / IV), Pt(III), synthesis and structures.

## Sem-II

**PAPER CEM204 (NANOTECHNOLOGY: PRINCIPLES AND PRACTICES), MARKS 50,**  
**CREDIT 4, LECTURES 45**

**(CBCS COURSE THAT OFFERS TO THE OTHER DISCIPLINE)**

**COURSE OUTCOME**

Students of other disciplines opt for the paper to gain knowledge on the smart material in the nano dimension range.

**Unit I: Introduction:** Bulk vs. Nano, Geometric structure, Magic numbers, co-ordination number of small clusters giving special emphasis on the synthesis, characterization and various wonderful properties of nanomaterials and their applications.

**Unit II: Synthesis of Nanomaterials:** Physical methods, Chemical methods, Biological methods. **Properties of Nanomaterials:** Mechanical properties, structural properties, melting of nanoparticles, electrical conductivity, optical properties, magnetic properties.

**Unit III: Analysis techniques:** Microscopes: Optical microscopes, Electron microscopes, Scanning electron microscope, Transmission electron microscope, Scanning probe microscope, Scanning tunneling microscope, Atomic force microscope, XRD, Spectroscopies: UV-VIS-NIR, Infrared (FTIR), Photo luminescence, XPS (X-ray photo electron spectroscopy), Auger electron spectroscopy.

**Unit IV: Application of Nanotechnology:** Electronics, Energy, Automobiles, Sports and Toys, Textiles, Cosmetics, Domestic applications, Biotechnology and medical field, space and Defense, Nanotechnology and environment.

**Sem – II**

**PAPER CEM 205 (Physical Practical): FULL MARKS 50, CREDIT 04, LECTURES 45) (Two days examination - 6 hours per day)**

- 1. List of Experiments:** 1. Kinetics of Inversion of Cane-sugar by Polarimeter.
2. Determination of dissociation constant and  $\Lambda^0$  of a weak monobasic acid conductometrically and verification of Ostwald's Dilution Law.
3. Conductometric determination of concentrations of KCl, HCl and NH<sub>4</sub>Cl in a mixture (one day).
4. Verify the Onsager equation using KCl, K<sub>2</sub>SO<sub>4</sub> and BaCl<sub>2</sub> as electrolytes and determine their A<sub>0</sub> values (one and half day).
5. Determine the solubility product of BaSO<sub>4</sub> conductometrically (one day).

6. Determination of CMC of a surfactant in aqueous solution by conductometric method (one day).
  7. Determination of strength of supplied KCl and  $K_{sp}$  of AgCl by a potentiometer.
  8. Potentiometric titration of halide mixture (Chloride, Bromide and Iodide).
  9. Determine the  $E^0$  value of  $Ag^+/Ag$  electrode and activity coefficients of different aqueous  $AgNO_3$  solutions potentiometrically (one day).
  10. Determine the standard potential of  $*Fe(CN)_6^{3-}/*Fe(CN)_6^{4-}$  electrode by potentiometer (one day).
  11. Determine the dissociation constants ( $K_1$ ,  $K_2$ , and  $K_3$ ) of  $H_3PO_4$  by pH meter (one day).
  12. Determination of  $pK_a$ ,  $pK_1$  and  $pK_2$  of a weak monobasic and dibasic acid pH-metrically.
  13. Determine the indicator constant of bromocresol green spectrophotometrically (one and half day).
  14. Study the kinetics of Iodination of acetone spectrophotometrically.
  15. Determination of composition of complexes (Ferric-salicylate complex/Ferrous-orthophenanthroline complex) by Job's method (one day).
  16. Determine the rate constant and the order of the reaction of  $KBrO_3$  & KI in acid medium (one and half day).
  17. Determine the order and rate constant of the reaction between  $K_2S_2O_8$  & KI and study the influence of ionic strength on the rate constant (two days).
  18. Study of the kinetic of alkaline hydrolysis of crystal violet. Determine the order with respect to alkali and salt effect on the system (two days).
  19. Determination of critical solution temperature (CST) and critical composition of two-component system.
- 2. Sessional Work:** To be awarded by the class teacher on the basis performance of the students during the practical classes. 10
- 3. Viva Voce:** To be jointly conducted by the external and internal examiners during the examination. 5

## SEMESTER – II

**PAPER CEM 206 (ORGANIC CHEMISTRY PRACTICAL) : MARKS 50, CREDIT 4,**  
**LECTURES 45) (Two days examination - 6 hours per day)**

**COURSE OUTCOME**

**Hands-on training on the topic thin layer chromatography (TLC), extraction of important biomolecules, one-step or two steps processes of organic syntheses.**

**1. Liquid Sample:** Qualitative analysis (color, odour, solubility etc.); Thin Layer Chromatography (TLC, preparation of TLC plates, analysis), boiling point determination; functional groups tests, UV-VIS spectral characterizations: (Measure  $\lambda$  max, and explain), Assign  $^1\text{H-NMR}$ ,  $^{13}\text{C-NMR}$  spectra, Identify the liquid substance.

**2. Extraction of Renewable chemicals:** Take a particular part of a plant such as fruit, leaf, bark, heavy wood, etc. Weight it. Extract with a particular solvent. Remove the volatiles. Purify. Weigh the product. Calculate % yield, Analyze the product by Thin Layer Chromatography, calculate Rf value. UV-VIS spectral characterizations: Measure  $\lambda$ max, and explain. Submit the product with the proper label.

**OR**

**2. Preparation** of pure organic compound single-step or two step procedure and submission of crystallized product: Table Preparation; Weigh the compound, calculate theoretical yield, prepare the compound, weigh the product, calculate % yield, crystallize, check M.P., submit crystallized product.

**3. Sessional Work** To be awarded by the class teacher on the basis performance of the students during the course work.

**4. Viva Voce** To be jointly conducted by the external and internal examiners during the examination.

**SEMESTER-III**

**(SPECIAL PAPER IS GIVEN TO THE ELIGIBLE STUDENTS)**

**PHYSICAL CHEMISTRY SPECIAL**

**CEM 301 (PHYSICAL SPECIAL): MARKS 50, CREDIT 4, LECTURE 45**

**COURSE OUTCOME**

**Students can gather knowledge on quantum mechanics, and group theory**

**Unit 1: Approximate method in QM-I** Approximate methods in quantum mechanics, variational principle, Eckart's Rule, Linear variation theorem, Hückel Theory and its

applications, analytical methods for linear and cyclic polyenes, Hückel Theory of systems containing hetero atoms, Extended Hückel Theory and its application.

**Unit 2: Approximate method in QM-II** Perturbation theory, derivation of perturbation equations, first-order non-degenerate and degenerate perturbation theory, applications, anharmonic oscillator, non-rigid rotator, Hydrogen molecule ion, Stark effect.

**Unit 3: Group Theory-I** Quantum mechanics and group representation theory, Direct product representation, Vanishing of quantum mechanical integral, Transition probability, Selection Rules, Projection operation, symmetry adapted linear combination of atomic orbitals.

**Unit 4: Group Theory-II** Application of group theory to molecular vibrations, Normal modes, Vibrational transitions, IR and Raman Spectra and Selection rule, Application of group theory to Ligand and crystal field theory, Symmetry and chemical reactions; Woodward –Hoffmann Rule.

### Sem-III

**PAPER CEM 302 (PHYSICAL SPECIAL): MARKS 50, CREDIT 4, LECTURE 45**

#### COURSE OUTCOME

**Topics like statistical mechanics, chemical kinetics, and Advance electrochemistry have been persuaded by the learners.**

**Unit-1: Statistical Mechanics-II** Concept of ensemble and phase space, ergodic hypothesis, temperature, canonical ensemble, distribution, Principle of equipartition of energy, chemically equilibrium system of interacting particles, imperfect gas. Grand canonical ensemble: nature of quantum particle, Bose- Einstein and Fermi-Dirac statistics, the specific heat of electron gas, Bose-Einstein condensation, quantum statistics, density matrix.

**Unit-2: Chemical Kinetics-I** Transition State Theory, thermodynamic formulation of reaction rates, Potential Energy Surface and contour reaction path, valley and Saddle point-activation energy; quantitative treatment of TST by using partition function; statistical formulation of chemical kinetics, equilibrium formulation, derivation of expression for specific reaction rate, the entropy of activation.

**Unit-3: Chemical Kinetics-II** Reaction in Molecular Beams, reactions in Shock Waves, Application of absolute reaction rate theory in viscosity, Reaction between ions, the influence of solvent dielectric constant (double sphere model), pre-exponential factors, single sphere activated complex model, the influence of ionic strength. Diffusion-controlled reactions (full and partial microscopic diffusion-controlled).

**Unit-4: Advanced Electrochemistry** Mechanism of multi-step electrochemical reactions, hydrogen overvoltage, thermodynamics of ideally polarized electrodes, structures of metal and semiconductor-electrolyte junctions, fundamentals of fuel cells, photoelectrochemical cells and corrosion.

### Sem-III

**CEM-303 (COMMON PAPER FOR ALL SPECIAL): MARKS 50, CREDIT 4, LECTURES 45**

#### COURSE OUTCOME

Common higher topics in Chemistry like Photophysical, LASER, EPR, PES and NQR are being learned by the students.

**Unit: 1 Photophysical processes:** Photophysical processes of 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 (both intra and intermolecular).

**Unit: 2 Laser and its applications:** General feature and properties of LASER, Method of obtaining population inversion, Laser cavity modes, Q-switching, Mode locking, Example of LASER: Ruby laser, Nd-YAG laser, diode laser, He-Ne laser, N<sub>2</sub> laser, Ar laser, excimer and exciplex laser, Dye laser.

**Unit: 3 EPR spectroscopy** Principle, spin Hamiltonian (comparison to NMR spectra), energy of spinning electron in a magnetic field, EPR-instrumentation, representation of EPR spectrum, X-band and Q-band spectra, line width, hyperfine splitting, magnetically equivalent and nonequivalent sets of nuclei, *g*-anisotropy, spectra of simple organic free radicals: expected number of lines, intensities. Spectra of transition metal complexes, metal hyperfine anisotropic spectra, zero-field splitting, application: determination of oxidation state of metal ion in samples.

**Unit: 4 PES and NQR spectroscopy** Photoelectron spectroscopy: Photoexcitation and photoionization, core level (XPS, ESCA) and valence level (UPS) photoelectron spectroscopy, XPS and UPS experiments, chemical shift, detection of atoms in molecules and differentiation of same elements in different environments from XPS, information about the nature of molecular orbitals from UPS, UPS of simple diatomic molecules e.g. N<sub>2</sub>, O<sub>2</sub>, CO, HCl etc. Principle of NQR, nuclear quadrupole coupling constant, structural information from NQR spectra.



**CEM 304 PHARMACEUTICAL CHEMISTRY (COMMON PAPER): MARKS 50, CREDIT 4, LECTURES 45**

**COURSE OUTCOME**

**Students will gain an understanding of pharmaceutical chemistry, structure-activity, and the evaluation of drugs.**

**1. Introduction of Pharmaceutical Chemistry**

Important aspects of pharmaceutical chemistry, importance of chemistry in pharmaceuticals, some important terms used in chemistry of drugs, pharmacopeia.

**2. Classification and nomenclatures of drugs**

Classification of drugs and their nomenclature.

**3. Theory of drug action and factors affecting the drugs**

Theory of drug action and structure activity relation, drug receptors: isolation, modification and localization, theories related to drug action.

**4. Types of drugs**

A. Hypnotics and sedative drugs, Anti-convulsant and analgesic drugs, general anaesthetics and local anaesthetics, expectorant, psychoactive and nervous system stimulant drugs, antiparkinson, antihistamine, anti-inflammatory and antipyretic drugs.

B. Antiamoebic, antifungal and antiviral drugs, antineoplastic agents, disinfectant and antiseptic, thyroid hormones and antithyroid drugs, Vitamins, sulfonamides and antibiotics.

**5. Antimalarial drugs**

Malaria parasite and its life cycle, chemotherapy of malaria using antimalarial drugs.

**SEMESTER – III**

**PAPER CEM 305 (PROJECT IN PHYSICAL CHEMISTRY): Full Marks 100, CREDIT 6**

**PAPER OUTCOME**

The pre-final project work will help the student to choose the novel problem in the subject of chemistry and allied fields emphasizing the review work and a concept (project) is found out to work further towards the partial fulfillment of the degree in Master in Chemistry.

**Industry Visit:** It will involve a visit to an Industry and submission of a Work-Report (approximately 10 pages) on the Industry Visit

**OR**

Field Work, Sample Collection and submission of a Work-Report (approximately 10 pages) on the Field Work. [20]

**Research Work: Unit 01: Review** in an area of contemporary interest: Topic to be finalized in consultation with the Incharge and a Review-Report (approximately 10 pages) has to be submitted. [10]

**Unit 02: Research** problem has to be finalized in consultation with the Incharge. The work has to be carried out under the supervision of the Incharge and Research Report of approximately 25 pages has to be submitted. [50]

**Unit 03 Seminar Lecture** has to be delivered on the total work carried out. It will involve Power Point Presentation (Industry visit: 2 slides, Review: 2 slides, Research work: 5 slides; total presentation time = 10 minutes (max.)). [20]

### SEMESTER-III

#### (INORGANIC CHEMISTRY SPECIAL)

**PAPER CEM 301 (INORGANIC CHEMISTRY SPECIAL): FULL MARKS 50, CREDIT 04, LECTURES 45**

#### **COURSE OUTCOME**

The outcome concentrates on the advanced topics like organometallics, application of group theory and chemistry of f-block elements

**Unit: 1 Organometallic Chemistry –II** Chemistry of transition metal complexes with cyclic polyenes: 3-6 membered ring systems. Sandwich and non sandwich complexes. Organometallic chemistry of heterocyclic ligands (N,B,O). Multidecker sandwich complexes. Bioorganometallic chemistry, Organometallic polymers, Main group organometallic chemistry.

**Unit: 2 Application of organometallic chemistry and catalysis** Terminology in catalysis: TO, TON, TOF. Unique reactions in organometallic chemistry and catalysis: Coordinative unsaturation, Substitution, Oxidative addition, Insertion (migration), Isomerization,

Reductive elimination; Catalytic converters; Alkene hydrogenation, Water gas shift reaction, Fischer Tropsch process. Hydroformylation (Oxo process), Carbonylation of olefins, Monsanto's acetic acid synthesis, Wacker oxidation (Pd-catalysed), Polymerization of olefins, Ziegler-Natta catalyst.

**Unit: 3 Chemical applications of group theory** (a) Splitting of orbitals and free ion terms in weak crystal fields, symmetries and multiplicities of energy levels in strong crystal fields, correlation diagram, Orgel diagram, Tanabe-Sugano diagrams, Effect of lowering of symmetry on the orbitals and energy levels, correlation table. Vanishing of quantum mechanical integral, transition probability, selection rules. Justification of Laporte selection rule, vibronic coupling and vibronic polarization, polarization of electronically allowed transitions. (b) Symmetry adapted linear combination of atomic orbitals, construction of MO for different system; LCAO-MO approximations Huckel theory for conjugated system. Symmetry of hybrid orbitals. Determine the symmetry and combinations of Ligand group Orbitals (LGO) and metal orbitals in octahedral, square planar, tetrahedral and other ligand environments using of projection operator. Construction of qualitative MO energy level and interaction diagram on the basis of symmetry considerations only. Drawing of LGO and MO diagrams. Application to IR and Raman spectra. Symmetry and chemical reactions; Woodward-Hoffmann rule.

**Unit: 4 Chemistry of f-block elements** Lanthanides. Actinides and Super heavy elements. Electronic structure, differences between 4f and 5f orbitals. Stable oxidation states. Lanthanide and Actinide construction, separation and isolation. Absorption spectra and magnetic properties. Comparative chemistry of d and f block elements, Comparative chemistry of Lanthanides and Actinides. Aqueous chemistry, coordination chemistry. Organic metallic compounds. trans actinide elements, nuclear instability and synthesis chemistry of U and Pu. Periodicity of trans Lawrencium elements, superactinides.

### Sem-III

**PAPER CEM 302 (INORGANIC CHEMISTRY SPECIAL): FULL MARKS 50, CREDIT 04, LECTURES 45**

**Unit: 1 Bioinorganic chemistry-II** Electron transfer (redox) enzyme: Catalase Peroxidase, Cytochrome P450, Super oxide dismutase, Ascorbate oxidase. Molybdenum containing enzymes: Nitrate reductase, Xanthine oxidase, Sulphate oxidase. Vanadium containing

protein: Amavadin, Vanadium bromo peroxidase. Vitamin B12, Chlorophil (Photosystem).  
Metal ions in genetic information transfer: Replication, transcription and translation process.

**Unit: 2 Nuclear chemistry** Nuclear models-nuclear forces, liquid drop model, Fermi gas model, Magic numbers. Nuclear spin and nuclear isomerism. Nuclear reactions-energetics, mechanism and models, nuclear fission and nuclear fusion. Nuclear reactors and particle accelerators. Interaction of radiation with matter.

**Unit: 3 Inorganic photochemistry** Introduction to inorganic photochemistry, photophysical and photochemical process, characteristics of the electronically excited states of inorganic compounds, ligand field states, charge transfer states, Frank Condon (FC) states, THEXI and DOSENCO states, kinetics of photochemical process, photosensitization. Transition probabilities, Transition moment integral and its applications. Selections rules. Jablonski diagram, Fluorescence and phosphorescence, delayed fluorescence, quantum yield, mechanism and decay kinetics of photophysical processes. Fluorescence quenching (dynamic and static), Stern-Volmer equation. Photochromism; chemical actinometry, photochemical reaction of coordination compounds. Photochemical splitting of water, photochemical conversion and storage of solar energy, organometallic photochemistry.

**Unit: 4 Solid state chemistry** Defects in solids, line and plane defects. Determination of equilibrium concentration of Schottky and Frenkel defects, Stoichiometric imbalance in crystals and non-stoichiometric phases, Color centres in ionic crystals. Band theory, band gap, metals, insulators, semiconductors (intrinsic and extrinsic), hopping semiconductors, rectifiers and transistors. Bonding in metal crystals: Free electron theory, electronic specific heat, Hall effect, electrical and thermal conductivity of metals, Superconductivity, Meissner effect, basic concepts of BCS (Bardeen-Copper-Schriffer) theory.

### Sem-III

**CEM-303 (COMMON PAPER FOR ALL SPECIAL): MARKS 50, CREDIT 4, LECTURES 45**

#### COURSE OUTCOME

Common higher topics in Chemistry like Photophysical, LASER, EPR, PES and NQR are being learned by the students.

**Unit: 1 Photophysical processes:** Photophysical processes of 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 (both intra and intermolecular).

**Unit: 2 Laser and its applications:** General feature and properties of LASER, Method of obtaining population inversion, Laser cavity modes, Q-switching, Mode locking, Example of LASER: Ruby laser, Nd-YAG laser, diode laser, He-Ne laser, N<sub>2</sub> laser, Ar laser, excimer and exciplex laser, Dye laser.

**Unit: 3 EPR spectroscopy** Principle, spin Hamiltonian (comparison to NMR spectra), energy of spinning electron in a magnetic field, EPR-instrumentation, representation of EPR spectrum, X-band and Q-band spectra, line width, hyperfine splitting, magnetically equivalent and nonequivalent sets of nuclei, g-anisotropy, spectra of simple organic free radicals: expected number of lines, intensities. Spectra of transition metal complexes, metal hyperfine anisotropic spectra, zero-field splitting, application: determination of oxidation state of metal ion in samples.

**Unit: 4 PES and NQR spectroscopy** Photoelectron spectroscopy: Photoexcitation and photoionization, core level (XPS, ESCA) and valence level (UPS) photoelectron spectroscopy, XPS and UPS experiments, chemical shift, detection of atoms in molecules and differentiation of same elements in different environments from XPS, information about the nature of molecular orbitals from UPS, UPS of simple diatomic molecules e.g. N<sub>2</sub>, O<sub>2</sub>, CO, HCl etc. Principle of NQR, nuclear quadrupole coupling constant, structural information from NQR spectra.

### Semester – III

**CEM 304 PHARMACEUTICAL CHEMISTRY (COMMON PAPER): MARKS 50, CREDIT 4, LECTURES 45**

#### COURSE OUTCOME

**Students will gain an understanding of pharmaceutical chemistry, structure-activity, and the evaluation of drugs.**

#### 1. Introduction of Pharmaceutical Chemistry

Important aspects of pharmaceutical chemistry, importance of chemistry in pharmaceuticals, some important terms used in chemistry of drugs, pharmacopeia.

#### 2. Classification and nomenclatures of drugs

Classification of drugs and their nomenclature.

#### 3. Theory of drug action and factors affecting the drugs

Theory of drug action and structure activity relation, drug receptors: isolation, modification and localization, theories related to drug action.

#### 4. Types of drugs

C. Hypnotics and sedative drugs, Anticonvulsant and analgesic drugs, general anaesthetics and local anaesthetics, expectorant, psychoactive and nervous system stimulant drugs, antiparkinson, antihistamine, anti-inflammatory and antipyretic drugs.

D. Antiamoebic, antifungal and antiviral drugs, antineoplastic agents, disinfectant and antiseptic, thyroid hormones and antithyroid drugs, Vitamins, sulfonamides and antibiotics.

### 5. Antimalarial drugs

Malaria parasite and its life cycle, chemotherapy of malaria using antimalarial drugs.

## Semester – III

### CEM 305

**PAPER CEM 305 (PROJECT IN INORGANIC CHEMISTRY): Full Marks 100,**  
**CREDIT 6**

#### PAPER OUTCOME

The pre-final project work will help the student to choose the novel problem in the subject of chemistry and allied fields emphasizing the review work and a concept (project) is find out to work further towards the partial fulfillment of the degree in Master in Chemistry.

**Industry Visit:** It will involve visit to an Industry and submission of a Work-Report (approximately 10 pages) on the Industry Visit

**OR**

Field Work, Sample Collection and submission of a Work-Report (approximately 10 pages) on the Field Work. [20

#### **Research Work:**

**Unit 01: Review** in an area of contemporary interest: Topic to be finalized in consultation with the Incharge and a Review-Report (approximately 10 pages) has to be submitted. [10

**Unit 02: The research** problem has to be finalized in consultation with the Incharge. The work has to be carried out under the supervision of the Incharge and a Research Report of approximately 25 pages has to be submitted. [50

**Unit 03 Seminar Lecture** has to be delivered on the total work carried out. It will involve PowerPoint Presentation (Industry visit: 2 slides, Review: 2 slides, Research work: 5 slides; total presentation time = 10 minutes (max.)). [20

## SEMESTER – III

### ORGANIC CHEMISTRY SPECIAL

**PAPER CEM 301 (ORGANIC CHEMISTRY SPECIAL): FULL MARKS 50, CREDIT 04, LECTURES 45**

**COURSE OUTCOME**

The student will learn the energetics of organics reactions, pericyclic reactions and organometallic chemistry.

**Unit-01: Pericyclic reaction 3:** Pericyclic reactions and applications of MO theory to Organic Chemistry : Electrocyclic reactions, Sigmatropic rearrangement, cycloaddition and cycloreversion reactions, cheletropic reactions, ene reaction. Frontier Molecular Orbital theory, concept of aromaticity of Transition States, orbital correlation diagrams, Huckel MO theory- MO's of chains and rings alternants and nonalternants.

**Unit 02: Linear Free Energy Relationship-1** Linear Free Energy Relationship: Quantitative correlations of rate and equilibria. Linear free energy relationships with special reference to Hammett, Taft, Yukawa-Tauno and Grunwald-Weinstein equations.

**Unit-03: Linear Free Energy Relationship-2** Application of Linear Free Energy Relationship to aromatic, aliphatic, polynuclear and hetero-aromatic systems. Multiparameter correlation reactions (elementary ideas). Electrophilic substitutions in aliphatic systems (SE1 and SE2 reactions).

**Unit-04: Organometallic Chemistry** Preparation and reactions of pi-complexes, heptonumbers, rules for nucleophilic addition to complexes, applications to typical synthesis. use of transition metals : organometallics in organic synthesis.

**Semester - III**

**PAPER CEM 302 (ORGANIC CHEMISTRY SPECIAL): FULL MARKS: 50, CREDIT 04, LECTURES 45**

**COURSE OUTCOME**

The students gain an advanced understanding of bioorganic and supramolecular chemistry.

**Unit-01: Bioorganic and Supramolecular Chemistry-I** Crown ethers: discovery, nomenclature, synthesis, properties and applications. Cryptands: structures and applications. molecular recognition: definition, examples of molecular recognition utilizing H-bonding, electrostatic, solvophobic, pi-pi interaction, etc., application of molecular recognition. H-bonding in molecular organization, chiral recognition, Introduction to molecular mechanics calculation and its use in the design of molecular receptors.

**Unit-02: Bioorganic and Supramolecular Chemistry-II** Cyclodextrins: Structure, property, applications. Enzymes: enzyme kinetics, mechanism; application of enzymes in organic synthesis, model enzymes based on cyclodextrins.

**Unit 03: Bioorganic and Supramolecular Chemistry-III** Self-assembling systems: micelles, reverse micelles; vesicles, fibers and tubules; amphiphiles, bola-amphiphiles, Self-replication. Gels: definition, classification, examples, study of the morphology and rheology of gels, applications Chemical sensors. Photo-responsive systems, Dye sensitized solar cell, Liquid Crystals, Molecular Electronic devices, organic conductors.

**Unit-04: Peptides and Nucleic acids** Peptides and Proteins: Structure and Functions;  $\alpha$ -helix,  $\beta$ -pleated sheet,  $\beta$ -turn, 3.10 helix, Ramachandran plot. Nucleic acids: Structure and functions; replication of nucleic acids.

**Unit-05: Green Chemistry** The current status of chemistry and the environment. What is green chemistry? How Green and Renewables are related to sustainability. Principles, methodologies and techniques in Green Chemistry. Synthesis in aqueous media, Catalytic methods in synthesis, Examples of green chemistry. Future trends in green chemistry. Unconventional energy sources in synthesis: solar energy.

**CEM-303 (COMMON PAPER FOR ALL SPECIAL): MARKS 50, CREDIT 4, LECTURES 45**

#### **COURSE OUTCOME**

Common higher topics in Chemistry like Photophysical, LASER, EPR, PES and NQR are being learned by the students.

**Unit: 1 Photophysical processes:** Photophysical processes of 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 (both intra and intermolecular).

**Unit: 2 Laser and its applications:** General feature and properties of LASER, Method of obtaining population inversion, Laser cavity modes, Q-switching, Mode locking, Example of LASER: Ruby laser, Nd-YAG laser, diode laser, He-Ne laser, N<sub>2</sub> laser, Ar laser, excimer and exciplex laser, Dye laser.

**Unit: 3 EPR spectroscopy** Principle, spin Hamiltonian (comparison to NMR spectra), energy of spinning electron in a magnetic field, EPR-instrumentation, representation of EPR spectrum, X-band and Q-band spectra, line width, hyperfine splitting, magnetically equivalent and nonequivalent sets of nuclei,  $g$ -anisotropy, spectra of simple organic free radicals: expected number of lines, intensities. Spectra of transition metal complexes, metal



hyperfine anisotropic spectra, zero-field splitting, application: determination of oxidation state of metal ion in samples.

#### **Unit: 4 PES and NQR spectroscopy**

Photoelectron spectroscopy: Photoexcitation and photoionization, core level (XPS, ESCA) and valence level (UPS) photoelectron spectroscopy, XPS and UPS experiments, chemical shift, detection of atoms in molecules and differentiation of same elements in different environments from XPS, information about the nature of molecular orbitals from UPS, UPS of simple diatomic molecules e.g. N<sub>2</sub>, O<sub>2</sub>, CO, HCl etc. Principle of NQR, nuclear quadrupole coupling constant, structural information from NQR spectra.

### **Semester – III (Organic Special)**

**CEM 304 PHARMACEUTICAL CHEMISTRY (COMMON PAPER): MARKS 50, CREDIT 4, LECTURES 45**

#### **COURSE OUTCOME**

**Students will gain an understanding of pharmaceutical chemistry, structure-activity, and the evaluation of drugs.**

#### **1. Introduction of Pharmaceutical Chemistry**

Important aspects of pharmaceutical chemistry, importance of chemistry in pharmaceuticals, some important terms used in chemistry of drugs, pharmacopeia.

#### **2. Classification and nomenclatures of drugs**

Classification of drugs and their nomenclature.

#### **3. Theory of drug action and factors affecting the drugs**

Theory of drug action and structure activity relation, drug receptors: isolation, modification and localization, theories related to drug action.

#### **4. Types of drugs**

E. Hypnotics and sedative drugs, Anticonvulsant and analgesic drugs, general anaesthetics and local anaesthetics, expectorant, psychoactive and nervous system stimulant drugs, antiparkinson, antihistamine, anti-inflammatory and antipyretic drugs.

F. Antiamoebic, antifungal and antiviral drugs, antineoplastic agents, disinfectant and antiseptic, thyroid hormones and antithyroid drugs, Vitamins, sulfonamides and antibiotics.

#### **5. Antimalarial drugs**

Malaria parasite and its life cycle, chemotherapy of malaria using antimalarial drugs.

### **SEMESTER – III**

**PAPER CEM 305 (PROJECT IN ORGANIC CHEMISTRY): Full Marks 100,**  
**CREDIT 6**

**PAPER OUTCOME**

The pre-final project work will help the student to choose the novel problem in the subject of chemistry and allied fields emphasizing the review work and a concept (project) is find out to work further towards the partial fulfillment of the degree in Master in Chemistry.

**Industry Visit:** It will involve visit to an Industry and submission of a Work-Report (approximately 10 pages) on the Industry Visit

**OR**

Field Work, Sample Collection and submission of a Work-Report (approximately 10 pages) on the Field Work. [20

**Research Work:**

**Unit 01: Review** in an area of contemporary interest: Topic to be finalized in consultation with the Incharge and a Review-Report (approximately 10 pages) has to be submitted. [10

**Unit 02: Research** problem has to be finalized in consultation with the Incharge. The work has to be carried out under the supervision of the Incharge and Research Report of approximately 25 pages has to be submitted. [50

**Unit 03 Seminar Lecture** has to be delivered on the total work carried out. It will involve Power Point Presentation (Industry visit: 2 slides, Review: 2 slides, Research work: 5 slides; total presentation time = 10 minutes (max.)). [20

**SEMESTER-IV**

**PHYSICAL CHEMISTRY SPECIAL**

**PAPER CEM 401 (PHYSICAL CHEMISTRY SPECIAL): FULL MARKS: 50,**  
**CREDIT:04, LECTURES: 45**

**COURSE OUTCOME**

**The students learn the topic of quantum mechanics for many-electron systems (diatomic and polyatomic), and atomic spectra.**

**Unit 1: Quantum mechanics of many-electron atoms:** Pauli's Antisymmetry principle, Slater determinant for the system with more than two electrons, Eigenfunctions of many-electron spin operator: Pure spin states, Energy expectation value of pure spin states; Orbitals

in many-electron atoms: The Hartree-Fock Theory, Koopman's theorem, The Hartree-Fock-Roothaan method for closed-cell systems, Roothaan equation.

**Unit 2: Atomic Spectroscopy:** Ground state electronic configuration of elements, Spectroscopic term symbol: LS coupling scheme, j-j coupling scheme, Electronic spectrum of many-electron atoms, Zeeman Effect in many-electron atoms, Electron correlation and method of configuration interaction.

**Unit 3: QM of diatomic molecules:** Born – Oppenheimer approximation, Solution of electronic Schrodinger equation for molecules, Valence bond method, The molecular orbital theory, MO term symbols, Comparison of MO and VB theory.

**Unit 4: QM of polyatomic molecules:** Separation of electronic and nuclear motion, Basis sets for the molecular orbital calculations of polyatomic molecules, Configuration interaction calculations of polyatomic molecules, Illustrative examples of Ab initio HF and Post HF calculations, Atomic charge and bonding Indices in polyatomic molecules.

#### Sem-IV

**PAPER CEM 402 (PHYSICAL CHEMISTRY SPECIAL): FULL MARKS: 50, CREDIT:04, LECTURES: 45**

#### COURSE OUTCOME

The topics like macromolecules, non-equilibrium thermodynamics, and solid-state chemistry have been demonstrated.

**Unit 1 : Non-equilibrium thermodynamics** Entropy production in irreversible processes, Onsager reciprocal relation, the principle of microscopic reversibility, thermonuclear pressure difference and thermonuclear effect, cyclic and oscillatory reactions, non-linear region, higher-order symmetries.

**Unit 2: Macromolecular & Biopolymers** Molecular weight of polymers, molecular weight determination by viscosity, osmometry, light scattering, diffusion and ultracentrifugation methods. Thermodynamics of polymer solutions. Kinetics of polymerization. Structures of biomolecules: 1) proteins –building, peptide bonds, primary, secondary, tertiary, quaternary structures. Phi-psi map. 2) Nucleic acids-A, B, Z conformations, t-RNA conformation, carbohydrates and lipids biomembrances. Methods for determination of molecular weight of biopolymers: a) SDS-PAGE (for proteins), b) agarose gel methods (for nucleic acids). Techniques to study biomolecules: CD, ORD, fluorescence, IR and Raman Spectroscopy (simple applications).

**Unit 3: Solid State – I** Electrical conductivity of metals; free electron theory of metals (classical and quantum theory), X-ray diffraction, Laue's diffraction, atomic scattering factor and Geometrical structure factor, Lattice vibration, Phonons and Excitons, Hall Effect.

**Unit 4: Solid State – II** Band theory of solids, conductors, semiconductors (n-type, p-type and n-p junction), superconductors and insulators. Lattice defects (Schottky defect and Frenkel defect). Color centre: F-centre, V-centre, F'-centre etc.

#### Semester - IV

#### (Physical Special)

**PAPER CEM 403 (PHYSICAL CHEMISTRY SPECIAL) (COMMON PAPER) SPECTROSCOPY FOR STRUCTURE ELUCIDATION:** FULL MARKS: 50, CREDIT:04, LECTURES: 45

#### COURSE OUTCOME

Analytical concepts to elucidate the structure of unknown compounds are being taught towards a meaningful understanding of the analyses.

**Unit 01** Detailed study of  $^1\text{H}$  NMR and preliminary aspects of  $^{13}\text{C}$  NMR, CW and FT techniques. Ring current: Aromaticity, Antiaromaticity, Homoaromaticity, Annulene systems.

**Unit 02** NMR spectroscopy: Principles, Relaxation phenomenon, factors influencing chemical shifts and coupling constants, simplification of the complex spectrum, NOE, Rotating frame of reference.

**Unit 03** Mass-spectrometry combined applications of spectroscopical methods to organic molecules: Principles of Mass spectrometry, Different techniques, fragmentation modes.

**Unit 04** Combined application of spectroscopic techniques (UV, IR, NMR, MS) in the elucidation of structure and study of reactions of organic compounds.

**Unit 05:** CD ORD and Mossbauer Spectroscopy.

#### Sem IV

#### (Physical Special)

#### CEM-404 (Common Paper) ()

**PAPER CEM 404 (PHYSICAL CHEMISTRY SPECIAL) (COMMON PAPER) FOOD PROCESSING AND PRESERVATION-II:** FULL MARKS: 50, CREDIT:04, LECTURES: 45

#### COURSE OUTCOME

The students will gain an understanding of food, beverages, milk, fruits & vegetables, fat & oil in light of chemistry.

**Unit 01: Milk Products:** Definition, composition of milk, Quality standards for milk, Pasteurization of milk; HTST and UHT techniques, Fermentation of milk, Manufacture of milk products like evaporated milk, Milk powder, Condensed milk, Cheese, Yoghurt, and Cream Butter. (8 Lectures)

**Unit 02: Cereals legumes and nuts:** Production of milled rice, Parboiling and parboiled rice, Processing of wheat, pulses, Corn, maize and malting. (8 Lectures)

**Unit 03: Fats and Oils:** Chemical composition, nutritional importance of dietary oils and fats, Production and processing of Edible vegetable oils and fat, hydrogenated fat. (8 Lectures)

**Unit 04: Food Safety:** Introduction, PFA, FPO, FSSA, HACCP, and Hygienic Design. (8 Lectures)

**Unit 05: Fruits and Vegetables:** Pre and post-harvest changes, Principles of fruits and vegetables processing, Storage of fresh fruits and Vegetables, Fruits and vegetables products like Jam, Jelly, Marmalades, Juices, Pickles, Sauces, Ketchup, Chutneys etc. (8 Lectures)

**Text books/ References:**

1. Robinson RK; 1996; Modern Dairy Technology, Vol 1 & 2; Elsevier Applied Science Pub.
2. Developments in Dairy Chemistry – Vol 1 & 2; Fox PF; Applied Science Pub Ltd.
3. Outlines of Dairy Chemistry, De S; Oxford.
4. Processing Fruits: Science and Technology, Vol. I, Biology Principles and Applications, L. Somogyi, Woodhead Publishing, 1st Edition, 1996.
5. Food oils and their uses; Weiss TJ; 1983, AVI
6. Modern Technology in the Oils and Fats industry by S.C. Singhal, OTA(I)
7. N.N. Potter CBS Publishers and Distributors, Delhi, 5th Ed, 1996 Food Science.

**Semester – IV**

**PAPER CEM 405 PROJECT PAPER (PHYSICAL SPECIAL): Full Marks = 100**

**PAPER OUTCOME**

The final year project work will help the student to achieve the course-work of higher Degree Ph. D and the dissertation were completed which reflects the ability to adopt new projects in the future.

**Research Work (extension from Semester III):**

**Unit 01: Skill to Read Research Articles:** A recent research article will be supplied and the students will have to answer some questions on the article. [20]

**Unit 02: Research** problem has to be finalized in consultation with the Incharge. The work has to be carried out under the supervision of the Incharge and Research Report of approximately 25 pages has to be submitted. [60]

**Unit 03 Seminar Lecture** has to be delivered on the total work carried out. It will involve Power Point Presentation (Total number of slides = 10; total presentation time = 10 minutes (max.)). [20]

## Semester – IV

### (INORGANIC CHEMISTRY SPECIAL)

**PAPER CEM 401 (INORGANIC CHEMISTRY SPECIAL): FULL MARKS: 50, CREDIT:04, LECTURES: 45**

#### COURSE OUTCOME

The students will gain an understanding of the topic of magnetochemistry, clusters, and supramolecular chemistry.

**Unit: 1 Magnetochemistry-I** Magnetic properties of substances, orbital and spin angular momentum of electrons, paramagnetic moment and magnetic susceptibility. Paramagnetic and diamagnetic materials, ferromagnetism, ferrimagnetism, antiferromagnetism, magnetic permeability, magnetic susceptibility, magnetization, classical theory of diamagnetism (Langevin's theory), classical theory of paramagnetism (Langevin's theory), diamagnetism and Pascal's constants, zero-field splitting, spin-orbit coupling. Determination of magnetic susceptibility by these methods: Gouy, Faraday and SQUID.

**Unit: 2 Magnetochemistry-II** Magnetic properties and temperature – The Curie and Curie-Weiss law, derivation of Curie law. Microstates, hole formalism, multiplet, multiplet width, Lande interval rule, magnetic moments for different multiplet widths, crystal field diagram, quenching of orbital contribution, high spin/low spin equilibrium. Antiferromagnetic interactions in inorganic compounds: Mechanism like – direct interaction, superexchange interactions and elucidation with poly nuclear metal complexes as well as oxide and halide salts of transition metals. Magnetic materials, long range ordering, superparamagnetism, molecular magnets, metamagnetism, single chain magnet, magnetic ordering, magnetic behaviour of lanthanides and actinides.

**Unit: 3 Metal carbonyls, clusters and metal-metal bonded compounds** Metal carbonyls: Synthesis, structure and reactivity. Low nuclearity (M3-M4) and high nuclearity (M5-M10) carbonyl clusters. Metal-metal bonding(MO), skeletal electron counting. Wade-Mingos-Lauher rule, isolobal analogy. Halide clusters of Nb, Ta, Mo, W, Re. Synthesis, structure and

bonding. Interstitial Clusters-hydrides, carbides and nitrides. Metal-metal multiple bond. Examples, syntheses, structures and bonding (MO). Electronic transition.

**Unit: 4 Supramolecular chemistry and designing of molecular materials** Origin of supramolecular chemistry-“Chemistry beyond the molecules”. Concepts and terminology of supramolecular chemistry. Natural types of supramolecular interactions (Hydrogen bonding, van der Waal’s interaction,  $\pi$ -stacking, CH-- $\pi$  interaction. supramolecular chemistry in inorganic perspective. Inorganic crystal engineering and design principle of metal organic framework (MOF) and inorganic-organic hybrid material. Application of MOFs in material science.

#### Semester - IV

#### Inorganic Chemistry Special

#### CEM 402

**PAPER CEM 402 (INORGANIC CHEMISTRY SPECIAL): FULL MARKS: 50, CREDIT:04, LECTURES: 45**

#### COURSE OUTCOME

**The students can learn the topics on reaction mechanisms in inorganic chemistry, and also gain ideas about analytical chemistry.**

**Unit: 1 Reaction mechanism of transition metal complexes** Energy profile of reactions, discussion on general reactivity of metal complexes, inert and labile complexes, different types of mechanisms („D“, „A“, „Ia“ and „Id“). Techniques for experimental measurements of reaction rates, techniques for fast reaction. Substitution reactions: Application of CFT, mechanism of ligand substitution in octahedral complexes, mechanism of isomerization and racemization, substitution reactions in square planar complexes. *Cis-* and *trans-* effects.

**Unit: 2 Electron transfer reactions and twist mechanism** Mechanism of redox reactions with reference to metal complexes. Electron transfer reactions – outer sphere and inner sphere, atom transfer, induced electron transfer reactions, two electron transfer reactions, noncomplementary reactions, synthetic implications of electron transfer reactions, solid state electron transfer reactions. Electroprotic reactions. Twist mechanism of racemization, inversion of configuration and associated process.

**Unit: 3 Analytical chemistry-I** Electroanalytical methods: Basic principles-polarised and depolarized electrodes; diffusion current, *dropping mercury electrode (DME)*, *polarographic wave*; Ilkovic equation (simplified derivation) and its significance; half-wave potential and its applications in identification of elements. Ilkovic-Heyrovsky equation, Cottrell equation. Stripping voltammetry, amperometric titration. Modern developments in polarographic techniques: Lingane’s method.

**Unit: 4 Analytical chemistry-II** Cyclic voltametry and Coulometry: Basic principle, three electrode configuration. Solvents and supporting electrolytes. Representation of cyclic voltammogram, half wave potential, irreversible, reversible and quasi-reversible redox processes. Electron transfer at a constant potential, no. of electron transfer. Application in coordination chemistry (characterization, determination of redox potential), e.g. ferrocene, Co(II)/Co(III); Ni(II)/Ni(III); Cu(I)/Cu(II); Ru(II)(bpy)<sub>3</sub> Thermal methods of analysis: Basic principles of Differential Thermal Analysis, Thermo Gravimetric Analysis. Application in coordination chemistry.

#### Semester – IV

#### Inorganic Chemistry Special

**PAPER CEM 403 (INORGANIC CHEMISTRY SPECIAL) SPECTROSCOPY FOR STRUCTURE ELUCIDATION**: FULL MARKS: 50, CREDIT:04, LECTURES: 45

#### COURSE OUTCOME

**Analytical concepts to elucidate the structure of unknown compounds are being taught towards a meaningful understanding of the analyses.**

**Unit 01** Detailed study of <sup>1</sup>H NMR and preliminary aspects of <sup>13</sup>C NMR, CW and FT techniques. Ring current: Aromaticity, Antiaromaticity, Homoaromaticity, Annulene systems.

**Unit 02** NMR spectroscopy : Principles, Relaxation phenomenon, factors influencing chemical shifts and coupling constants, simplification of complex spectrum, NOE, Rotating frame of reference.

**Unit 03** Mass-spectrometry combined applications of spectroscopical methods to organic molecules : Principles of Mass spectrometry, Different techniques, fragmentation modes.

**Unit 04** Combined application of spectroscopic techniques (UV, IR, NMR, MS) in elucidation of structure and study of reactions of organic compounds.

**Unit 05:** CD ORD and Mossbauer Spectroscopy.

#### Semester - IV

**PAPER CEM 404 (INORGANIC CHEMISTRY SPECIAL) FOOD PROCESSING AND PRESERVATION-II**: FULL MARKS: 50, CREDIT:04, LECTURES: 45

#### COURSE OUTCOME

**The students will gain an understanding of food, beverages, milk, fruits & vegetables, fat & oil in light of chemistry.**



**Unit 01: Milk Products:** Definition, the composition of milk, Quality standards for milk, Pasteurization of milk; HTST and UHT techniques, Fermentation of milk, Manufacture of milk products like evaporated milk, Milk powder, Condensed milk, Cheese, Yoghurt, and Cream Butter. (8 Lectures)

**Unit 02: Cereals legumes and nuts:** Production of milled rice, Parboiling and parboiled rice, Processing of wheat, pulses, Corn, maize and malting. (8 Lectures)

**Unit 03: Fats and Oils:** Chemical composition, nutritional importance of dietary oils and fats, Production and processing of Edible vegetable oils and fat, hydrogenated fat. (8 Lectures)

**Unit 04: Food Safety:** Introduction, PFA, FPO, FSSA, HACCP, and Hygienic Design. (8 Lectures)

**Unit 05: Fruits and Vegetables:** Pre and post-harvest changes, Principles of fruits and vegetables processing, Storage of fresh fruits and Vegetables, Fruits and vegetables products like Jam, Jelly, Marmalades, Juices, Pickles, Sauces, Ketchup, Chutneys etc. (8 Lectures)

**Text books/ References:**

5. Robinson RK; 1996; Modern Dairy Technology, Vol 1 & 2; Elsevier Applied Science Pub.
6. Developments in Dairy Chemistry – Vol 1 & 2; Fox PF; Applied Science Pub Ltd.
7. Outlines of Dairy Chemistry, De S; Oxford.
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7. N.N. Potter CBS Publishers and Distributors, Delhi, 5th Ed, 1996 Food Science.

**Semester – IV**

**PAPER CEM 405 PROJECT PAPER (INORGANIC SPECIAL): Full Marks = 100**

**PAPER OUTCOME**

The final year project work will help the student to achieve the course-work of higher Degree Ph. D and the dissertation were completed which reflects the ability to adopt new projects in the future.

**Unit 01: Skill to Read Research Articles:** A recent research article will be supplied and the students will have to answer some questions on the article.

**Unit 02: Research** problem has to be finalized in consultation with the Incharge. The work has to be carried out under the supervision of the Incharge and Research Report of approximately 25 pages has to be submitted.

**Unit 03 Seminar Lecture** has to be delivered on the total work carried out. It will involve Power Point Presentation (Total number of slides = 10; total presentation time = 10 minutes (max.).

### Semester – IV Chemistry: Organic Special

#### ORGANIC CHEMISTRY SPECIAL

CEM 401

PAPER CEM 401 (ORGANIC CHEMISTRY SPECIAL): FULL MARKS: 50, CREDIT:04, LECTURES: 45

#### COURSE OUTCOME

**The students gain an understanding of the topics of organic photochemistry, and bio-relevant organic compounds.**

**Unit 01: Organic Photochemistry-1** Organic Photochemistry: Fundamental concepts, Jablonski diagram, Photochemistry of organic compounds, Norrish type- I and type II processes, Paterno Buchi reaction, Barton reaction, addition reaction, oxidation reaction.

**Unit 02: Organic Photochemistry-2** Photochemical reduction, substitution reaction, cis-trans isomerism, photochemistry of butadiene, di-pi methane rearrangement and related processes.

**Unit 03: Biological Active Molecules** Antibiotics, Penicillin, Cephalosporin, streptomycin, Structure, Synthesis and biological activity to bacteria.

**Unit 04: Vitamins and co-enzymes** Vitamins A1, B1, C, K coenzymes, NAD, FAD and reactivity of different Vitamin in biological reactions. Chemistry of nucleosides, nucleotides and ATP, elementary structure and role of DNA and various types of RNA's in protein biosynthesis.

**Unit 05: Heterocycles-2** Heterocycles: Synthesis and Reactions: Generalized approach to the synthesis of heterocycles possessing 5-,6-, and 7- membered rings with one or two heteroatoms per ring. Reactions of heterocycles: oxidation and reduction reactions with electrophiles, nucleophiles and other reactive intermediates with typical monocyclic and fused ring systems as examples.

## Semester - IV

**PAPER CEM 402 (ORGANIC CHEMISTRY SPECIAL): FULL MARKS: 50, CREDIT:04, LECTURES: 45**

<p><b>COURSE OUTCOME</b></p> <p><b>The students gain an understanding of the topics of advanced stereochemistry of organic molecules.</b></p>
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**Unit-01: Stereochemistry-3** Conformation and Chemical Reactivity : Curtin-Hammett principle, its derivation under different conditions and applications; quantitative treatment of mobile systems, Winstein Holness equation and Eliel equation - their applications ;  $\square$   $\square$ -Strain and  $\square$   $\square$ -strain, allylic 1,2 - and 1, 3-strain (in pseudoallylic systems also), their applications.

**Unit-02: Stereochemistry-4** Fused ring systems, *trans* and *cis* declaims, conformation, steroid and nonsteroid conformation, symmetry, torsion angle enthalphy, entropy, free energy, substituted declaims q-methyldecalins and 9,10 dimethyldecalins, decalones; conformation of cis-octalins and trans-octalins.

**Unit 03: Stereochemistry-5** Stereochemistry of 4-10 membered rings, transannular reactions; perhydrophenanthrenes and perhydroanthracenes conformation, energy, symmetry and optical activity, relative stability, stereochemistry of perhydrodiphenic acids and perhydrophenanthrenes, conformations of some triterpenes.

**Unit- 04: Stereochemistry-6** Modern concepts of nucleophilic addition to carbonyl compounds, Felkin model (torsional strain) Burzi Dunitz trajectory, Cieplak model, examples.

**Unit- 05: Stereochemistry-7** Optical rotation, specific and molecular rotations-their units, Brewster rule, Lowe's rule , origin of optical rotation, circular birefringence, optical rotatory dispersion (ORD) octant rule, axial haloketone rule-application (octant projection diagrams) ; circular dichroism (CD) differential dichronic absorption, specific ellipticity and molar ellipticity, applications of CD-helicity rule, exciton chirality (dibenzoate chirality rule) Davydor splitting-applications with different steroidal glycols.

## Semester - IV

**PAPER CEM 403 (ORGANIC CHEMISTRY SPECIAL) SPECTROSCOPY FOR STRUCTURE ELUCIDATION: FULL MARKS: 50, CREDIT:04, LECTURES: 45**

<p><b>COURSE OUTCOME</b></p> <p><b>Analytical concepts to elucidate the structure of unknown compounds are being taught</b></p>
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towards a meaningful understanding of the analyses.

**Unit 01** Detailed study of <sup>1</sup>H NMR and preliminary aspects of <sup>13</sup>C NMR, CW and FT techniques. Ring current: Aromaticity, Antiaromaticity, Homoaromaticity, Annulene systems.

**Unit 02** NMR spectroscopy : Principles, Relaxation phenomenon, factors influencing chemical shifts and coupling constants, simplification of complex spectrum, NOE, Rotating frame of reference.

**Unit 03** Mass-spectrometry combined applications of spectroscopical methods to organic molecules : Principles of Mass spectrometry, Different techniques, fragmentation modes.

**Unit 04** Combined application of spectroscopic techniques (UV, IR, NMR, MS) in elucidation of structure and study of reactions of organic compounds.

**Unit 05:** CD ORD and Mossbauer Spectroscopy.

#### Sem-IV

**PAPER CEM 404 (ORGANIC CHEMISTRY SPECIAL) FOOD PROCESSING AND PRESERVATION-II: FULL MARKS: 50, CREDIT:04, LECTURES: 45**

#### COURSE OUTCOME

**The students will gain an understanding of food, beverages, milk, fruits & vegetables, fat & oil in light of chemistry.**

**Unit 01: Milk Products:** Definition, composition of milk, Quality standards for milk, Pasteurization of milk; HTST and UHT techniques, Fermentation of milk, Manufacture of milk products like evaporated milk, Milk powder, Condensed milk, Cheese, Yoghurt, and Cream Butter. (8 Lectures)

**Unit 02: Cereals legumes and nuts:** Production of milled rice, Parboiling and parboiled rice, Processing of wheat, pulses, Corn, maize and malting. (8 Lectures)

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7. N.N. Potter CBS Publishers and Distributors, Delhi, 5th Ed,1996 Food Science.
8. Desroiser and Desroiser,CBS Publishers and Distributors,New Delhi,4th Ed,1987 Technology of Food preservation.

**Semester – IV CEM 405****PAPER CEM 405 PROJECT PAPER (ORGANIC SPECIAL): Full Marks = 100****PAPER OUTCOME**

**The final year project work will help the student to achieve the course-work of higher Degree Ph. D and the dissertation were completed which reflects the ability to adopt new projects in the future.**

**Unit 01: Skill to Read Research Articles:** A recent research article will be supplied and the students will have to answer some questions on the article. [20]

**Unit 02: Research** problem has to be finalized in consultation with the Incharge. The work has to be carried out under the supervision of the Incharge and Research Report of approximately 25 pages has to be submitted. [60]

**Unit 03 Seminar Lecture** has to be delivered on the total work carried out. It will involve Power Point Presentation (Total number of slides = 10; total presentation time = 10 minutes (max.)). [20]