West Bengal State University (WBSU)

Department of Chemistry
Syllabus for M.Sc. in Chemistry Under NEP (Semester Programme)
For 2 YEAR PG
[w.e.f. 2026-2027 session]

Programme Specific Outcome

The purpose of the postgraduate programme in chemistry at West Bengal State University is to provide a firm foundation and prepare students for careers as professionals in the field of chemistry and the chemical industry. Students graduating with M.Sc. in chemistry will have an understanding of the fundamentals of chemistry in areas of Inorganic & Analytical, Organic and Physical Chemistry. He should be able to extend his knowledge in application areas of current chemical and scientific theories and research. The course will equip the students for doctoral research in chemistry, spectroscopy, biological chemistry and related fields, and to prepare the students with a chemistry background that will allow them to become effective scientist or teachers in the higher education institutes.

The course has been so designed such that the students would be able to independently design and carry out scientific experiments as well as accurately record and analyse the results of such experiments. They are trained to be reasonably skilled in problem solving, critical thinking and analytical reasoning as required for scientific problems.

The research component will allow the students to develop the ability to explore new areas of research in both chemistry and allied fields of chemistry. They should learn to function as a member of an interdisciplinary problem-solving team involved in inter-disciplinary research.

NEP COURSE STRUCTURE FOR 2 YEAR PG

Semester	I		II		III		IV		Total
Credit	22		20		22		24		88
Marks	300		250		300		300		1150
Course Type	Theo	Pract	Theo	Pract	Theo	Pract	Theo	Lab	
Core	150	100	150	100	150	50	200		900
AECC		50							50
DSE					50$		50		100
SEC					50 (Theory)				50
Project								50	50

$: Spectroscopy/Analytical

The experiments detailed in the syllabus are indicative in nature. The specific experiments can be changed subject to available infrastructural conditions. The department will endeavour to introduce new protocols with advancement of the discipline.

SEMESTER I

Marks 300 Total Credit Points (CP) : 22

Course Code	Course Type	Courses	Marks		Total
	CHEM		Th	Pr	
CEM2PCOR01T	Theory(Inorganic)	Chemistry of coordination compounds 1 Bioinorganic Chemistry 1 Organometallics 1 Different methods of Electrochemical analyses	50		50 (CP = 4)
CEM2PCOR02T	Theory(Organic)	Theory and methods in structure-activity relationship Bioorganic Chemistry Pericyclic Reactions Heterocyclic Compounds	50		50 (CP = 4)
CEM2PCOR03T	Theory(Physical)	Mathematics for physical chemistry Electrochemistry Thermodynamics Chemical kinetics 1	50		50 (CP = 4)
CEM2PCOR04P	Practical	• Inorganic + Physical		50	50 (CP = 4)
CEM2PCOR05P	Practical	• Organic + Physical		50	50 (CP = 4)
CEM2PAEC01M	Mixed	• Computer Language	50		50 (CP = 2)

SEMESTER II

Marks 250 Total Credit Points (CP)20

Course Code	Course Type	Course	Marks		Total Marks
	CHEM		Th	Pr	
CEM2PCOR06T	Theory(Inorganic)	Chemistry of coordination compounds 2 Bioinorganic Chemistry 2 Organometallics 2 Solid state chemistry	50		50 (CP = 4)
CEM2PCOR07T	Theory(Organic)	NMR Carbohydrate chemistry Reagents in organic synthesis Natural Products	50		50 (CP = 4)
CEM2PCOR08T	Theory(Physical)	Quantum mechanics 1 Macromolecules Fundamentals of spectroscopy Statistical mechanics 1	50		50 (CP = 4)
CEM2PCOR09P	Practical	Inorganic + Physical		50	50 (CP = 4)
CEM2PCOR10P	Practical	Organic + Physical		50	50 (CP = 4)

SEMESTER III

Marks 300 Total Credit Points (CP) : 22

Course Code	Course type	Course	Marks	Total Marks
	CHEM		Th Pr	
CEM2PCOR11T	Theory(Inorganic)	Nuclear chemistry Chemistry of d-block elements Chemistry of f-block elements Symmetry and Group theory	50	50 (CP = 4)
CEM2PCOR12T	Theory(Organic)	Organometallic chemistry Organosulphur and Organophosphorus Compounds Photochemistry Asymmetric Synthesis	50	50 (CP = 4)
CEM2PCOR13T	Theory(Physical)	Quantum mechanics 2 Symmetry and group theory Nanomaterial Statistical mechanics 2	50	50 (CP = 4)
CEM2PDSE01T	Theory (Spectroscopy/Analytical Chemistry)	1. Spectroscopy Group A- ESR spectroscopy Atomic spectra Group B- Mass spectra Chiroptical properties of organic compounds Group C- Emission spectroscopy 2. Analytical chemistry	50	50 (CP = 4)
CEM2PCOR14P	Practical	Physical + (Organic + Inorganic)	50	50 (CP = 4)
CEM2PSEC01T	Theory	Chemical and Spectral Analysis	50	50 (CP = 2)

SEMESTER IV

Marks 300 Total Credit Points(CP) : 24

Course Code	Course Type	Course	Marks Th	Marks Pr	Total Marks
CEM2PCOR15T	(Inorganic)	Inorganic ring, cage, cluster Inorganic reaction mechanism Magnetochemistry Advanced bioinorganic chemistry	50		50 (CP = 4)
CEM2PCOR16T	(Organic)	Advanced NMR Spectroscopy Organoboron and Organosilicon Compounds Advanced Pericyclic Chemistry Medicinal Chemistry	50		50 (CP = 4)
CEM2PCOR17T	(Physical)	Quantum mechanics and spectroscopy Laser Quantum mechanics 3 Biophysical chemistry	50		50 (CP = 4)
CEM2PCOR18M	Research Project		50		50 (CP = 4)
CEM2PCOR19M	Literature Review and Grand Viva		50		50 (CP = 4)
CEM2PDSE02T	Theory [Theoretical Chemistry / Application Oriented Chemistry]	Theoretical chemistry Chemical application of group theory Advanced Stereochemistry Advanced topics in photophysics Application oriented chemistry Spectroscopic analysis of Inorganic compounds and thermal analysis Supramolecular Chemistry Material chemistry	50		50 (CP = 4)

Semester I

CEM2PCOR01T

InorganicChemistry-1

Unit 1 : Chemistry of coordination compounds I **13M**

Crystal field theory, Splitting of d-orbitals in linear, triangular, tetrahedral, square planar, trigonal bipyramidal, square pyramidal and octahedral fields of similar and dissimilar ligands. Crystal field stabilization energies in weak field and strong field environment, hole formalism, inversion and equivalence reactions, splitting of d_n terms in octahedral and tetrahedral fields, Octahedral site preference energy, Tetrahedral distortion and Jahn Teller effect. Effect of crystal field stabilization on ionic radii, lattice energy, hydration enthalpy and stabilization of complexes (Irving Williams order). Substitution reaction in square planar complexes, Kinetics of octahedral substitution, Thermodynamic and kinetic stability, Kinetic aspects of crystal field stabilization. Crystal field activation energy. Labile and inert complexes, Mechanism of different substitution reactions of octahedral complexes. Limits of applicability of crystal field theory. Shapes of complexes.

Unit 2 : Bioinorganic chemistry I **12M**

Elements of life, Essential and trace elements in biological systems. Basic reactions in the biological systems and roles of metal ions in biological processes. Metal ions transport and storage proteins: ferritin, transferin, ceruloplasmin. Transport across biological membrane – Na_+-K_+-ATPase, ionophores. Hydrolytic enzymes: carbonic anhydrase, carboxy peptidase, urease. Metal dependent diseases: Wilson's disease, Alzheimer disease. Metal complexes as drugs: Pt and Au drugs. Toxic effects of metal ions, detoxification by chelation therapy.

Unit 3: Organometallics 1 **13M**

Reactions of organometallic complexes: substitution, oxidative addition, reductive elimination, insertion and elimination, electrophilic and nucleophilic reactions of coordinated ligands. Stereochemical non-rigidity and fluxional behaviour of organometallic compounds with examples. Metal-alkyl, -allyl, -carbene, -carbonyl, -carbide and cyclopentadienyl complexes. Structure and bonding in η^2-ethylenic and η^3-allylic compounds with typical examples, structure and bonding of $K[Pt(C_2H_4)Cl_3]$, $[(Ph_3P)_2Pt(Ph\text{-}C{\equiv}C\text{-}Ph)]$.

Unit 4 : Different methods of Electrochemical analyses **12M**

Use of three electrode system, standard electrodes and applications. Voltammetry, cyclic voltammetry, polarography, anodic stripping voltammetry, amperometry, coulometry, electrogravimetry, Dropping mercury electrode, stripping voltammetry.

CEM2PCOR02T

OrganicChemistry-1

Unit 1 : Theory and Methods in Structure-activity Relationship **13M**

Hückel Molecular Orbital Theory, Method and Application to acyclic and cyclic conjugated systems - ethylene, allyl, cyclopropenyl, butadiene, cyclobutadiene, pentadieneyl, cyclopentadienyl, hexariene, benzene, fulvene, systems involving heteroatoms, Extended Hückel Theory(EHT): Basic concept. Huckel's rule and concept of aromaticity, alternant and non-alternant hydrocarbons, anti aromaticity, pseudoaromaticity, homo-aromaticity. Criteria of aromaticity: annulenes, heteroannulenes, fullerenes (C_{60}). PAHs: Clar's and Fries Concept of aromaticity, Frost diagram: Concept, formation and application related to aromatic property. Linear Free Energy Relationship for substituent effect: Hammett equation, applications and its modifications.

Unit 2 : Bioorganic Chemistry **12M**

Classification and characteristics of enzymes. Salient features of active site of enzymes. Molecular recognition and Mechanism of enzyme action: Static and dynamic recognition, Lock and Key model, Induced fit model. Examples of hydrolysis of peptides by chymotrypsin (role of catalytic triad, oxyanion hole) in small intestine and conversion of pyruvate to lactic acid by lactate dehydrogenase in cytoplasm. Factors regulating enzyme action: enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition). Coenzymes and cofactors and their role in biological reactions.
Biomimetic chemistry, Molecular models of biological receptors Design, Synthesis and binding studies of synthetic receptors, Enzyme models: enzyme kinetics, inhibition, immobilisation and application, Cyclodextrin, Remote functionalisation reaction,

Unit 3 : Pericyclic Reactions **13M**

Classification and stereochemical modes. Thermal and photo pericyclic reactions. Selection rules and stereochemistry of electrocyclic reactions. 2-component cycloadditions. Sigmatropic rearrangement. Carbene addition. Rationalization based on Frontier MO approach, correlation diagrams. Dewer-Zimmermann approach. Mobius and Huckel systems, Cope and Claisen rearrangement. Ene-reaction.

Unit 4 : Heterocyclic Compounds **12M**

Heterocycles in organic synthesis. Masked functionalities, Umpolung,6- membered heterocycles with two hetero atoms. General approach to heterocycle synthesis, cyclisation, cycloaddition route. Synthesis and reactions of pyrimidines, pyridazines, pyrazines, purines, quinazolines, alloxan, barbituric acid, cinnolines, quinoxalines.

CEM2PCOR03T

Physical Chemistry-1

Unit-1: Mathematics for Physical Chemistry **13M**

Mathematical Functions in Physical Chemistry: functions in thermodynamics, quantum mechanics, continuity, graphs of functions. important families of functions; coordinate systems in two and three dimensions; Mathematical operations with complex numbers, vectors and vector algebra, Problem solving and the solution of algebraic equations, differential calculus, integral calculus, Thermodynamic Variables Related to Partial Derivatives Exact and Inexact Differentials Integrating Factors Maximum and Minimum Values of Functions of Several Variables Constrained Maximum/Minimum Problems Lagrange's Method of

Undetermined Multipliers; Mathematical series, differential equations; Eigenfunctions and eigenvalues, operator algebra, Matrix algebra.

Unit-2: Electrochemistry **12M**

Ion solvent interactions. Debye Hückel theory and its extensions. Application of Debye Hückel theory – Limiting law, Debye Hückel Onsager theory and its extension. Debye-Falkenhagen effect, Wien effect. Gouy Chapman & Stern models. Bjerrum model for ion association: Formation of ion pairs, derivation of ion- association constant; Photo-electrochemistry at surface solution interface, Photoelectrochemical splitting of water and carbon dioxide, Electrode kinetics- Nernst, Butler-Volmer equation, Tafel equation.

Unit-3: Thermodynamics **13M**

Carnot cycle; 2nd law of thermodynamics, Clausius inequality; Entropy changes of systems and surroundings for various processes and transformations; Entropy and unavailable work; Auxiliary state functions (G & A) and their variation with T, P and V. Criteria for spontaneity and equilibrium. Maxwell's relations: Gibbs-Helmholtz equation. Relation between chemical potential and Gibbs free energy and other thermodynamics state functions; variation of chemical potential with temperature and pressure; Variation of thermodynamics functions for systems with variable composition; Changes in G, S, H and V during mixing of binary solutions. Nernst heat theorem; third law of thermodynamics: Unattainability of the absolute zero of temperature.

Unit 4: Chemical Kinetics-I **12M**

Collision theory and activated complex theory. Reactions between ions: influence of solvent dielectric constant (double sphere model), single sphere activated complex model, influence of ionic strength. Unimolecular reactions: Qualitative analysis of RRK and RRKM theory; Chain reactions. Kinetics of fast reactions: flow method, relaxation method, flash photolysis. Oscillatory reactions: Observation and mechanism. Autocatalytic reaction.

PRACTICAL

CEM2PCOR04P

Group – A

1. **Synthesis of some metal complexes:**
   hexaminecobalt(III) chloride, Reineki salt, bis(biguanido) copper(II) sulphate, bis (acetylacetonato) oxovanadium (IV), bis(tetraethylammonium) tetrahalonickelates (II), bis(tetraethylammonium) tetrachloro manganate(II) etc.

2. **Complexometric Estimation of mixture of metal ions**
   Fe(III) and Al(III) mixture,
   Cu(II) and Zn(II) mixture,
   Fe(III) and Ca(II) mixture.

3. **Spectrophotometric Determination** of
   i) Fe(II) in mixture, ii) Mn(II) in mixture, etc.

4. **Analysis of Complex Materials-(Part 1)**
   Quantitative analysis of complex materials, such as, ores and minerals, metals and alloys, industrial materials by conventional and/or instrumental methods as applicable.

Model Samples

Ores, Minerals , Concentrates:

Dolomite ($CaCO_3$, Mg CO_3, Fe_2O_3, SiO_2); Pyrolusite (MnO_2, MnO, Fe_2O_3); Chalcopyrite (CuS, FeS); Bauxite (Al_2O_3, Fe_2O_3, TiO_2, SiO_2); Chromite (Cr_2O_3, Fe_2O_3, MnO, SiO_2); Basic slag (Al_2O_3, Fe_2O_3, P_2O_5, SiO_2).

Group – B

1. pH-metric titration of a polybasic acid and determination of its basicity and dissociation constants
2. Determination of Isoelectric Point of Gelatine
3. Determination of Solubility Product of PbI_2
4. Conductometric Titration of a Mixture of Halides (KCl + HCl + NH_4Cl) by i) NaOH and ii) $AgNO_3$

CEM2PCOR05P

Group -A

- **Some Single-step organic synthesis/transformation including few Green methods**
  1. Bromination of acetanilide to *p*-bromoacetanilide,
  2. Photoinduced transformation of benzophenone to benzopinacol,
  3. Base promoted hydrolysis of methyl salicylate,
  4. Rearrangement: Benzil to benzilic acid (in Solid phase)

  e*tc.*
- **Identification of organic compounds from the mixture of two solid compounds:**

  - Separation on the basis of solubility
  - Detection of functional group(s) present in each constituent organic compound (not more than two functional groups in a component)
  - Preparation of derivative
  - Determination of melting points of the separated organic compounds.
  - Determination of the melting point of the derivatives.
  - Identification of two solid compounds individually by means of checking melting points of the compounds and their corresponding derivatives with the help of the melting points reported in literature.

Group - B

1. Spectrophotometric determination of pK_{In} of Bromocresol Green and determination of Isosbestic point.
2. Potentiometric Titration of (KI+KCl) by $AgNO_3$ solution.
3. Determination of E_o of the Quinhydrone electrode by potentiometric method
4. Determination of Hydrolysis Constant of a Salt with the Help of a pH-meter
5. Kinetic study of the autocatalytic reaction between potassium permanganate and oxalic acid.

Semester II

CEMPCOR06T

Inorganic Chemistry–2

Unit 1: Chemistry of coordination compounds II **13M**

Electronic spectra of transition metal complexes : Microstates, determination of ground and excited state terms of $d^1$to d^9ions in octahedral and tetrahedral fields; Orgel diagrams, selection rules for spectral transitions, *d-d* spectra of d^n ions and crystal field parameters, nephelauxetic series. Spectroscopic approach of metal ligand orbital overlap, Metal-ligand bonding (pictorial MO approach): sigma and pi-bonding in complexes, Different types of CT transitions.
Construction of molecular orbital diagrams of coordination complexes (Oh and Td), sandwich complexes ML_6 (with and without pi-bonding), ML_4 (tetrahedral) and (square planar) : Sandwich complex (ferrocene etc)

Unit 2: Bioinorganic Chemistry II **12 M**

Transport and storage of dioxygen: Active site structures and bio functions of O_2-uptake proteins: haemoglobin, myoglobin, hemocyanin and hemerythrin; model synthetic dioxygen complexes.
Electron transfer in biology: Active site structures and functions of cytochromes, cytochrome *c*; iron-sulfur proteins (ferredoxins). Photosynthesis and chlorophylls, photosystem-I and photosystem-II and their roles in cleavage of water. Model systems. Biological and a biological nitrogen fixing systems, model study.

Unit 3 Organometallics 2 **13M**

Catalysis by Organometallic compounds: Hydrogenation of olefins, Wilkinson's catalyst, Tolman catalytic loop; synthesis gas, water-gas shift reaction; Hydroformylation (oxo process), Monsanto acetic acid process, Wacker process; synthetic gasoline: Fischer-Tropsch process and Mobile process, polymerization, oligomerization and metathesis reactions of alkenes and alkynes, Zieglar- Natta catalysis , photo dehydrogenation catalyst (platinum POP).

Unit 4: Chemistry of Solid state **12 M**

Crystal defects and Non- Stoichiometry: Perfect and imperfect crystals, intrinsic and extrinsic defects- point, line and plane defects, vacancies- Schottky and Frenkel defects. Determination of equilibrium concentrations of Schottky and Frenkel defect formation, non-stoichiometric defects, colour centres in ionic crystals, stoichiometric imbalance in crystals**.**
Bonding in metal crystals: Free electron theory of metals, chemical and quantum mechanical concept, specific heat, Hall effect and its quantum manifestation, Band theory of metals: band gap, electrical and thermal conductivity of metals, p-n junction semi-conductors (intrinsic and extrinsic), insulators, rectifiers and transistors, super conductors.

CEM2PCOR07T

OrganicChemistry-2

Unit-1 : Nuclear Magnetic Resonance Spectroscopy **13M**

Basic Principle, Nuclear spin, Nuclear resonance, Basic instrumentation, FT-NMR (qualitative idea) and its advantages, Saturation, Chemical shift and its measurements, Shielding-deshielding, Factors influencing chemical shift, Spin-Spin interactions, Factors influencing coupling constant `J`. Classification of molecules: ABX, AMX, ABC, A_2B_2, *etc.*, Spin decoupling, first order and non first order spectra. Basic principle of NOE and its application, Concept of difference spectra, preliminary concept of COSY. Introduction to CMR: Basic idea. Sensitivity, Proton decoupled and non-decoupled CMR, Off Resonance CMR. Applications of NMR in medical diagnosis: Brief idea related to MRI.

Unit 2 : Carbohydrates **12M**

Basic structure and type of sugars; Protection and deprotection chemistry, Deoxysugars, aminosugars, glycalsugars and their synthetic aspects, Synthetic approach (Combinatorial) towards polysachharides of biological and industrial importance, Carbohydrate as chiral pools in organic synthesis.

Unit-3 Reagents in Organic synthesis **13M**

One electron and two electron oxidants, Oxidations with Cr (VI): Jones oxidation, Collins oxidation PCC, PDC, PFC; DMSO based oxidations: Swern, Moffat, DMSO-SO_3 complex, DMSO-acetic anhydride, Hypervalent iodine oxidations: Dess-Martine periodinane, IBX, Iodobenzenediacetate; Oxidations with thalium nitrate, Ag_2O, RuO_4, OSO_4, $NaIO_4$.
Reduction with metal-hydrides of B, Al, Sn, Si. Dissolving metal-reduction, Synthetically useful hydrogenolysis reaction, Sm- and In-based reducing agents.

Unit-4: Natural Products **12M**

Terpenoids: Isoprene rule. Structure elucidation (by chemical and spectroscopical methods). Synthesis, Biogenesis and Biosynthesis of representative examples of acyclic, monocyclic and bicyclic monoterpenes. Structural types, General introduction to sesqui-, di- and tri- terpenoids.
Alkaloids & Steroids: Familiarity with methods of structure elucidation (Chemical and spetroscopical methods); Bio-synthesis; Synthesis and Biological activity of some alkaloids (morphin, reserpin). General methods of study and structural types; Chemistry of cholesterol, hormones, bile-acids.

CEM2PCOR08T

Physical Chemistry-2

Unit-1: Quantum Mechanics-I **13M**

Postulates of quantum mechanics and their analysis; Properties of operators and commutators; Time-independent Schrodinger equation; Concept of stationary states, Free particle, Particle in a one- dimensional box, Barrier problems and tunneling phenomenon; Equations of motion; Ehrenfest's theorems, Angular momentum operators, Eigenvalues and eigenfunctions, Hydrogen atom Problem: Cartesian and Polar coordinates. Centre of Mass and relative coordinate, Spherical harmonics. Real and complex orbital, Role of the constant of motion.

Unit-2: Macromolecules **12M**

Definition of Polymers; Types of Polymers; Polymerization process — condensation, addition, radical chain, ionic, condensation polymerization, copolymerization; Kinetics of Polymerization, chain transfer, retardation, inhibition; Polymerization in homogeneous and heterogeneous systems; Polymerization conditions; Mechanisms of polymerization; Molecular mass of Polymers, their determination. Biomacromolecules (Proteins & DNA).

Unit-3: Fundamentals of Spectroscopy **13M**

General introduction, nature of electromagnetic interaction, shapes and width of spectral lines, intensity of spectral lines, Fourier transform, Microwave spectroscopy: Moment of inertia and classification of molecules, Energy expression for symmetric rotor. Stark Effect and determination of Dipole moment. Non-rigid rotor, Breakdown of Born-Oppenheimer approximation, vibrational-rotational spectra.

Unit-4: Statistical mechanics-I **12M**

Probability, thermodynamic probability and entropy, Maxwell-Boltzmann statistics, Partition function: translational (for ideal gas - concept of thermal wavelength), rotational, vibrational and electronic partition functions (diatomic molecule); molecular and molar partition function, Qualitative idea of statistics (Bose-Einstein, Fermi-Dirac statistics): Thermodynamic probability and distribution formula (without derivation), comparison with classical statistics - distinguishability and indistinguishability of identical particles. Evaluation of translational, rotational and vibrational partition functions for monatomic, diatomic and polyatomic gases; Calculation of thermodynamic properties of ideal gases in terms of partition function. Calculation of equilibrium constants of gaseous solutions in terms of partition function, Application to chemical/ionization equilibrium.

PRACTICAL

CEM2PCOR09P

Group – A

(1) Analysis of Complex Materials (Part 2)

Quantitative analysis of complex materials, such as, ores and minerals, metals and alloys, industrial materials by conventional and/or instrumental methods as applicable.

Model Samples

Metals and Alloys:

Brass (Cu, Zn); Soldier / Type metal (Pb, Sb, Sn); Bronze(Cu, Zn, Sn), Aluminium bronze(Cu, Al, Fe, Mn), Steel (Cr, Mn, Ni, P).

(2) Analysis of Mixture:

Chromium (III) and Mn(II) in a mixture

(3) Kinetics studies on redox reactions:

(A) Model system:

Determination of the rate constants of reduction of the complex, $[Co(NH_3)_5(N_3)]Cl_2$, by aqueous Fe^{2+} ions by spectrophotometric method.

Kinetics studies on linkage isomerism:

(B) Model system:

Kinetic investigation of transformation of the complex, $[Co(NH_3)_5(ONO)]Cl_2$ to $[Co(NH_3)_5(NO_2)]Cl_2$ by spectrophotometric method.

Kinetics studies on substitution reactions:

Model system:

Kinetic investigation of the substitution reaction, $[Co(NH_3)_5(SO_3)^+] + NO_2^- \rightarrow$ by spectrophotometric method.

Kinetics studies on protolysis reaction:

Model system: Kinetic investigation on protolysis of the complex, $[Co(NH_3)_5(CO_3)^+]$ ion by spectropotometric method.

Group – B

1. Spectrophotometric Study of the Alkaline Hydrolysis of Crystal Violet. (Determination of rate constant "k" and order "n" with respect to alkali)
2. Determination of equilibrium constant of acid hydrolysis of an ester.
3. Determination of Critical Micelle Concentration (CMC) of SDS by Conductometry
4. Potentiometric titration of acetic acid by sodium hydroxide using quinhydrone electrode.
5. Kinetic Study of the Iodination of Aniline by Colorimetric Method.

CEM2PCOR10P

Group – A

(I) Extraction, purification and spectroscopic study of Natural Product.

- Extraction of Caffeine from tea leaves (commercially available tea-bags) by solvent extraction method.
- Determination of melting point.
- Spectroscopic study of the extracted compound:
  - IR
  - UV
  - NMR
- Purification:
  - Method of sublimation
- Derivatisation: caffeine salicylate, determination of its melting point.

(II) Multistep synthesis of some organic molecules, study of the progress of reaction by TLC and purification (crystallisation/chromatography) .

Group – B

1. Verification of Onsager Equation and Determination of λ_0 and Ka of Acetic Acid
2. Kinetic Study of the Inversion of Sucrose
3. Determination of the Standard Redox Potential (E_o) of Ferrocyanide – Ferricyanide System
4. Kinetic Study of the Reaction between $K_2S_2O_8$ and KI and study on the effect of Added salt on the Rate constant.
5. Studies on Kinetics of Iodination of Acetone.

Semester III

CEM2PCOR11T

Inorganic Chemistry-3

Unit 1: Nuclear Chemistry & Radiochemical Analysis 13 M

Nuclear models: Nuclear forces, liquid drop model, shell model, Fermi gas model; magic numbers, nuclear spin and nuclear isomerism.
Nuclear reactions: Energetics, mechanism and models of nuclear reactions. Nuclear fission and nuclear fusion, fission products and fission yields. Interactions of radiation with matters, chemical effects of nuclear transmutation (elementary idea), Nuclear reactors and particle accelerators.
Radioactive Techniques: Detection and measurement of radiation- GM ionization and proportional counters. Study of chemical reactions by tracer techniques, isotope exchange and kinetic isotope effect. Radiometric analysis: Isotope dilution analysis, age determination, neutron activation analysis (NAA) and their applications. Radiation hazards and safety measures.

Unit 2: Chemistry of d-Block Elements 12M

Electronic configuration, oxidation states; aqueous, redox and coordination chemistry, spectral and magnetic properties of compounds in different oxidation states, horizontal and vertical trends in respect of 3d, 4d, and 5d elements with references to Ti-Zr- Hf , V-Nb-Ta, Cr- Mo- W, Mn- Tc-Re and Pt group metals.
Mixed valence compounds of Fe, Cu, Pt; Fe-S compounds, cobaloxime related compounds, conformational changes and thermochromism of Ni(II) compounds, Ru(II) and Ru(III) compounds, oxo compounds of Ru and Os, Rh(I) and Ir(I) carbonyl halide and carbonyl hydrides. Aqueous chemistry of Be_{II} and Al_{III}, basic beryllium compounds.
Synthesis, properties, reactions, structure and bonding as applicable in respect of: Mo-blue, W- blue, Pt-blue, W-bronze, Ru-red.

Unit 3: Chemistry *f*– Block Elements: Lanthanides and Actinides 13M

Nuclear stability, terrestrial abundance and distribution, relativistic effect, electronic configuration, oxidation states, aqueous-, redox- and complex- chemistry; electronic spectra and magnetic properties. Lanthanide and actinide contractions and their consequences, separation of lanthanides and actinides and their applications (examples).
Compounds of Sc, Y, La and Ac; Ce(III) and Ce(IV) compounds and their reactions, Lanthanide compounds as high temperature superconductor, NMR shift reagent and MRI reagent.

Unit-4 : Symmetry and Bonding 12M

Symmetry in nature, symmetry elements and symmetry operations. Symmetry properties of atomic orbitals. Elements of group theory, multiplication tables, point groups and their stereographic projections. Born-Oppenheimer approximation, LCAO-MO and VB treatments on H^{2+}, H_2 ; application to homo- and hetero-nuclear diatomic molecules/ ions of second period elements, electron density, forces and their role in chemical bonding. Hybridization and valences, Bonding in homo-nuclear and heteronuclear diatomic molecules of 2nd period. Bonding in triatomic (H_3^+ ,BeH_2, H_2O), tetraatomic (BH_3, NH_3), CO, NO and

CH_4. MO diagrams. Huckel–pi–electron theory and its applications to ethylene, allyl, butadiene and benzene, idea of self consistent field. Concept of resonance

CEM2PCOR12T

Organic Chemistry-3

Unit-1: Organometallics **13M**

Synthesis, Structure, Bonding, Oxidative insertion, Reductive elimination, Ligand migration from metal to carbon, C-H activation. Organometallic reagents in organic synthesis and in homogeneous catalytic reactions: Hydrogenation, Asymmetric-hydrogenation, Hydroformylation, Isomerisation and Polymerisation. Pi-acid metal complexes, Activation of small molecules by coordination, Coupling reaction: Heck, Stille, Suzuki, Negishi, Sonogashira, Hiyama, Butchwald-Hartig, Ullmann. Olefin metathesis: RCM, Grubb's catalyst (1^{st}, 2^{nd}, 3^{rd} generation catalyst). PEPPSI, Tebbe's reagent, Pauson Khand reaction, Functional organometallic compounds, Use of Indium, Zinc, Samarium.

Unit-2: Organosulphur and Organophosphorus Compound **12M**

Organosulphur: Chemistry of organosulphur compounds. Sulphur-stabilization of anions and cations. Synthesis, stability and application of Sulphonium salts, Sulphonium and sulphoxonium ylides, Chiral sulphoxides to the organic transformation. Rearrangements involving organosulphur compounds.

Organophosphorus: Chemistry of organophosphorus compounds. Phosphorus ylides: Synthesis, stability and application. Wittig reaction and its modifications (HWE, Schlosser); Chiral phosphines; Phosphine-oxides and its applications. Rearrangements involving organophophorus compounds.

Unit-3: Photochemistry **13M**

Basic principles, Direct and sensitized reactions, Photochemistry of carbonyl compounds; Norish type-I and Norish type-II reaction; β-cleavage; Photo-oxidation and Photo-reduction; Photocycloaddition; Patterno-Buchi reaction; Photo rearrangement(dienone); Photochemistry of olefinic compounds; Photo-isomerisation (cis-trans isomerisation); Photo-cycloaddition; Di-pi methane rearrangement; Photochemistry of aromatic compounds.

Unit-4: Asymmetric Synthesis **12M**

Principles and newer methods of asymmetric synthesis (Including enzymatic and catalytic nexus); Enantio and diastereoselective synthesis; Addition to carbonyl compounds; Reactions of enolates (α-substitution), Alkylation, Asymmetric aldol reaction, Addition to C-C double bond(Electrophile induced cyclization, iodolactonization, hydroboration, conjugate addition, Diels-Alder cycloaddition, cyclopropanation); Reduction of C-C double bond; Carbonyl and Imine groups; Oxidation, Epoxidation, Dihydroxylation, and mono-hydroxylation; Rearrangement: [3,3]-sigmatropic, [2,3]-Wittig, Alkene isomerisation, Hydrolysis and esterification.

CEM2PCOR13T

Physical Chemistry-3

Unit-1: Quantum Mechanics-II 13M

Particle on a ring, on a spherical surface and rigid rotor. Ladder operators; quantum harmonic oscillators, solution of Hermite differential equation, algebraic solution for the ground and excited states of quantum harmonic oscillator, Calculation of various quantities (matrix elements, selection rule etc.) using ladder operators and recursion relations of Hermite polynomials; Variational theorem and variational methods. Use of these methods illustrated with different examples (anharmonic oscillator, approximate functions for particle in a box and hydrogen atom, ground state of helium atom).

Unit-2: Symmetry & Group Theory 12M

Introduction of symmetry elements and symmetry operations; Classification of molecules; Group, subgroup etc., class, character; point groups, point group symbols; representations; great orthogonality theorem and its consequences; irreducible representations of point group, statement of grand orthogonality theorem, orthogonality theorem for characters, character tables, concept of character projection operator. Symmetry adapted linear combination (SALC) with illustrative examples.

Unit-3: Nanomaterials 13M

Nanomaterial- definition and properties, relevance to dependency on size and shape. Synthetic methodologies both physical and soft chemical methods: i) mechanical methods, ii) Evaporation methods, iii) CVD, iv)Sol-gel, v) Microemulsion (normal and reverse micelles formation), vi) Template based synthesis, vii) reduction methods . Various kind of Nanostructures; Quantum dot (QDs), Carbon Nanotubes, (SWCNT, MWCNT), Fullerene, Graphene, etc. Application of nanomaterials.

Unit-4: Statistical Mechanics-II 12M

Concept of ensemble and ergodic hypothesis, phase space; microcanonical ensemble, counting micro-states, Gibbs paradox, correct enumeration of the microstates, Sackur-Tetrode equation; System of interacting molecules, treatment of imperfect gases, Canonical ensemble distribution, probability distribution function, its relation with different thermodynamic state functions; application to a system of harmonic oscillators; the statistics of para-magnetism, energy fluctuations in the canonical ensemble, equipartition and the virial theorem

CEM2PDSE01T

Spectroscopy **50M**

Group-A **17M**

Electron spin resonance spectroscopy

Basic principles, Principle of EPR and spin Hamiltonian (comparison to NMR spectroscopy), external standard, line-width, nuclear hyperfine interactions, anisotropy in Lande g factor and hyperfine interaction, zero field splitting, and Kramer`s degeneracy, factors affecting the `g` value. Isotropic and anisotropic hyperfine coupling constants, spin Hamiltonian, spin densities. Basic instrumentation, measurement techniques and simple applications regarding structural information of organic radical and inorganic molecules from EPR spectra.

Atomic spectra
The hydrogen atom: Energy levels and selection rules; Many-electron atoms; The Clebsch–Gordn series; Spin–orbit coupling; Selection rules for atomic absorption and emission: E1, M1, and E2 allowed transitions; Hyperfine structure; The effect of external fields: The Zeeman effect; The Stark effect.

Group-B **17M**

Mass spectra: Basic instrumentation, ion production -EI, CI, FD and FAB techniques, Mass spectral fragmentation of typical organic compounds, common functional groups.

Chiroptical properties of organic molecules: Linearly and circularly polarised lights; circular birefringence and circular dichroism; ORD and CD curves: Cotton effect; application of CD and ORD: comparison method, use of plane curves, CD and ORD curves with Cotton effect; Haloketone rule, the octant rule, Sector rule, Helicity rule.

Group-C **16M**

Emission spectroscopy

Franck-Condon principle, Mirror-image symmetry and its violation, Radiative and radiationless deactivation, Oscillator strength, Fluorescence Quenchers and life-time variations, 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.

CEM2PDSE01T

Analytical Chemistry **50M**

Unit-1: Fundamentals of Chemical Analysis **13 M**

Aim of analytical chemistry. Standardization and calibration. Quality assurance and quality control. Process control and validation. Classical methods of analysis: Gravimetry and titrimetry including neutralization, complexation and oxidation-reduction. Complex acid-base equilibrium. Separation of metal ions as their hydroxides, sulphides and chelates. Examples of gravimetric and complexometric analysis.

Unit-2: Solvent Extraction and Concept of Chromatography **12 M**

Liquid-Liquid extraction – Cross and counter current process, multiple batch extraction, solvent extraction of metal ion, solid-phase extraction. Classification of chromatographic separation. Aqueous biphasic and supercritical fluid extraction. Band broadening and column efficiency, Theoretical plate model and the Rate theory of Chromatography.

Unit-3: Liquid Chromatography and Other Types of Chromatography: **13 M**

Reverse and normal phase chromatography, gradient elution, solvent selection and classes, ion exchange and ion chromatography.
HPLC: Basic equipment, pumping and injection system, column stationary phase and structural types of column packing, Detector systems (UV, IR, Conductometric, Fluorescence), Sample preparation and applications.

Gas chromatography: gas-liquid and gas-solid chromatography, types of column and selection. Basic equipment, Injection systems, Detectors (FID, TCD, ECD, NPD) for GC, sample separation and applications. Characteristics and applications of Size exclusion Chromatography, Affinity chromatography, Supercritical Fluid Chromatography, Capillary Electrophoresis.

Unit- 4: Kinetics in Analytical Chemistry **12 M**

Significance of reaction kinetics in analytical chemistry. Determination of rate of fast reactions.

Analytical application of catalytic and non-catalytic reactions in single species and pseudo single species systems. Differential reaction rate methods of analysis and its limitations, determination of inorganic and organic mixtures.

PRACTICAL

CEM2PCOR14P

Group – A

1. Study of the determination of the decomposition of hydrogen peroxide by acidified KI, maintaining a constant excess of iodide. Determination of the rate constant at four different temperatures and hence determination of the energy of activation, enthalpy of activation and entropy of activation of the reaction.
2. Verification of the Onsager equation and Conductometric determination of Solubility Product of a sparingly soluble salt.
3. Determination of the Co-ordination number of copper in copper-ammonia complex.
4. Determination of the Standard Electrode Potential (E_o) of Ag/Ag^+ system and Activity Coefficient of Ag^+ ions in solution.
5. Determination of equilibrium constant for the formation of Iron (III) Thiocyanate complex.

Group – B

Advanced Physicochemical Experiments

Model Experiments:

Determination of composition of complexes formed in solution by spectrophotometric methods:

a) Mole-ratio method
b) Slope- ratio method
c) Job's method of continuous variation

Model systems:

Fe^{III}-sulfoslicylic acid complex
Fe^{II}- (1,10- phenanthroline) complex
Cu^{II}- ethylenediamine complex
Zn^{II}-alizarin-S complex

Determination of stability constants of metal-ligand complexes by pH-metric methods:

Model systems:

i) Cu(II)-glycinate complexes
ii) Cu^{II}-sulfosalicylate

Semi-Micro Qualitative Inorganic Analysis:

Semi-Micro Qualitative Inorganic Analysis of complex inorganic mixtures containing not more than six (6) inorganic radicals from the lists **(a), (b), (c),** and **(d),**of which two (2) radicals must be derived from the rare elements **(d)**, and the mixture should not contain more than one insoluble material from the lists **(c),** and **(d),** :

(a) Cation Radicals derived from:
Ag, Cu, Sn, Fe, Al, Cr, Co, Ni, Mn, Zn, Ba, Sr, Ca, Mg, Na, K and NH^{4+} ions.
SCN^-, S^{2-}, $S_2O_3^{2-}$, SO_3^{2-}, NO^{2-}, NO^{3-}, PO_4^{3-}, AsO_4^{3-}, BO_3^{3-}, H_3BO_3, SiO^{2-}, CrO_4^{2-}, $Cr_2O_7^{2-}$, $[Fe(CN)_6]^{4-}$, $[Fe(CN)_6]^{3-}$ ion.

(b) Anion Radicals:
F^-, Cl^-, Br^-, I^-, BrO^{3-}, IO^{3-}

(c) Insoluble Materials:
$PbSO_4$, $BaSO_4$,$SrSO_4$, CaF_2, $SiO_2$and various silicates, SnO_2, Al_2O_3, Fe_2O_3, Cr_2O_3

(d) Cation radicals, anion radicals and insoluble materials derived from the following rare Elements: V, Mo, W, Ti, Zr, Ce, Th.

Group – C

Some synthetic methodology involving protection/deprotection chemistry, derivatisation of amino acids, carbohydrates etc.

CEM2PSEC01T **50M**

Group-A **25M**

(1) Elucidation of different methods of synthesis and characterization of inorganic and coordination compounds-some representative examples.

A. Preparation of N,N-bis(salicyldehyde)ethylenediamineCo(II) (salen compound) and similar compounds.

B. Selected coordination compounds with some common inorganic and organic ligands with bi-, tri- and/or polydentate N, O donor ligands. Complexation and estimation of metal ions present in coordination complexes

C. Mn_{12} clusters and other Mn clusters, their characterisation and role as single molecular magnets. Examples of other SMM materials.

(2) Parameters of water analysis

A) Procedure of analysis of BOD, COD, DO, TOC etc.

B) Procedure for analysis of ammonia, total nitrate and nitrite, chloride, fluoride, phenols etc.

Group-B **25M**

Structural determination and elucidation of organic compounds using combined spectral data like Mass, IR, NMR, UV *etc.* The methodical and logical workflow based on different spectroscopical data and logical analysis to enhance the problem solving skills.

- Theoretical principle and application
- Practical problem-solving strategies
- To determine molecular formula and unsaturation: DBE, Rule of thirteen, Nitrogen rule.
  - Systematic deduction of molecular fragments (Mass spectrometry)/framework by the use of and by cross-referencing Spectral data.
- Use of UV data to apply the same for detection and/or speculation of extended conjugation, chromophores.
- Using IR data for the determinations of functional groups, group vibrations.

Semester IV

CEM2PCOR15T

Inorganic Chemistry - 4

Unit-1 : Inorganic Rings, Cages and Clusters **13M**

Polymorphism of C, P and S. Structure and bonding in higher boranes and borohydrieds- Lipscomb's topological models, Wade`s rules, carboranes and metallocene carboranes.

Metal-metal bonding (M.O. Approach), metal-metal single and multiple bonded compounds. Low nuclearity (M_3, M_4) and high nuclearity (M_5-M_{10}) carbonyl clusters: skeletal electron counting, Wade-Mingos-Louher rule, Application of isolobal and isoelectronic relationships, Nb and Ta clusters, Mo and W clusters. Cluster compounds in catalysis.

Unit - 2 : Inorganic Reaction Mechanism **12M**

Mechanism of electron transfer reactions: 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.

Mechanism of substitution reactions, solvent exchange, aquation, anation, base hydrolysis, acid catalyzed aquation, pseudo-substitution. Four broad classes of mechanism of substitution-D, A, Ia and Id. Mechanism of isomerization reaction-linkage isomerism, cis-trans isomerism, intramolecular and intermolecular racimization, Ray-Dutta and Bailar twist mechanisms.

Unit 3: Magneto chemistry **13M**

Magnetic properties of transition metal compounds: Types of magnetic materials. Magnetic susceptibility and its determination: Gouy, Faraday methods , vibrating sample magnetometer, SQUID and NMR methods. Magnetic anisotropy, diamagnetism in atoms and polyatomic systems, Pascal's constants. Spin and orbital moments, spin-orbit coupling, quenching of orbital moment, spin only formula, temperature dependence of magnetic moment, spin cross over, Lande interval rule, energies of J states. Curie equation, Curie law and Curie-Weiss law.

First order and second order Zeeman effects, temperature independent magnetism, implication and application of van Vleck susceptibility equation, quenching of orbital moment, magnetic properties of transition metal complexes in cubic and axially symmetric crystal fields, low spin- high spin crossover,

Unit 4: Advanced Bioinorganic Chemistry III **12M**

Metal ion interactions with purine and pyrimidine bases, nucleosides, nucleotides and nucleic acids, DNA and RNA, metal ions in genetic information transfer. Different possible ways of DNA interaction.

Metalloproteins catalyzing oxygen atom transfer reactions: Iron systems such as Siderophores and Catecholase. 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.

Biological function of nonmetallic elements (other than C, H, O, N, S, P). Vitamins and coenzymes: Vitamin B_6 and vitamin B_{12} coenzymes, their roles, model systems.
Bioenergetic principle, Role of ATP, Glycolysis and Kreb's cycle. Respiratory electron transport chain, cytochrome C-oxidase.

CEM2PCOR16T

Organic Chemistry-4

Unit-1: Advanced NMR Spectroscopy **13M**

Introduction to Vector model (Bloch vector model) of NMR: Pulse technique (90^0 x pulse etc.), FID, Multiple Pulses. Relaxation Process: Longituidinal relaxation, Transverse relaxation, Field Inhomogeneity (T1, T2, T2*), 2D NMR. Application of DEPT and Correlation spectroscopy. COSY, HMBC, HMQC, TOCSY, NOESY, ROESY in structure elucidation of organic compounds, Reaction monitoring and Drug screening. Basic Idea of Solid State NMR (CP-MAS).

Unit-2: Organoboron and Organosilicon Compounds **12M**

Organoboron: Chemistry of organoboron compounds. Hydroboration, Reduction. Reactions of organoboranes. Application of organoboron in organic transformations. Unsaturated hydrocarbon synthesis; Allylborane and boron enolates.

Organosilicon: Chemistry of organosilicon compounds. β-carbocation and α-carbanion stability. Synthetic uses of silyl ethers; Silyl enol ethers; TMSCl, TMSI, TMSCN, Alkene synthesis, Alkenyl, Vinyl, Aryl, Allyl and Acyl silanes and their applications in organic synthetic methodology. Brook rearrangement; Silicon Baeyer-Villiger rearrangement.

Unit-3: Advanced Pericyclic Chemistry **13M**

General perturbation molecular orbital theory in cycloaddition reaction: Reactivity, Regioselectivity and Periselectivity, Cheletropic reactions, 1,3-dipolar cycloaddition, Cycloadditions involving more than six electrons, Three and four component cycloaddotion, Ene reactions, Group transfer reactions and eliminations, Electrocyclic reactions of charged systems, Sigamatropic rearrangement: [1,5] and [1,7] shifts in neutral systems, [3,3] shifts, Cope rearrangements, Claisen rearrangement, [5,5] shifts, [2,3] shifts in ylides.

Unit-4: Medicinal Chemistry **12M**

Pharmacodynamics: Different types of drugs and drug targets, Drug binding forces, Role of enzymes, Drug receptor interactions, Mechanism of drug action, Agonists, Antagonists, Affinity, Efficacy and potency of drug, Dose response curves.
Pharmacokinetics: Drug absorption, Distribution, Metabolism (Phase-I and Phase-II transformations), Excretion. Basic concept of Drug design and synthesis, De Novo design, Molecular recognition, Receptor based molecular modelling, QSAR studies, Cardiovascular drugs, Local anti-infective drugs, Analgesics, Antibiotics and CNS active drugs.

CEM2PCOR17T

Physical Chemistry-4

Unit-1: Quantum Mechanics and Spectroscopy **13M**

Theoretical basis of interaction of radiation with matter: Harmonic perturbation and transition probabilities, Selection rule for vibrational spectra, anharmonic correction by perturbation - appearance of overtones, derivation of selection rule for rotational spectra of a rigid rotor, Derivation of selection rules for vibrational and rotational Raman scattering, Quantum mechanical representation of transition polarizability in Raman scattering by the Kramers-Heisenberg-Dirac (KHD) equation; Use of symmetry of wavefunctions in evaluation of transition matrix elements. Application of group theory to molecular vibrations, and Raman spectra.

Unit-2: Laser **12M**

Principles of Laser and Maser action. Population inversion (two/three/four level systems),Characteristics of Laser Radiation, CW and Pulsed Laser, Harmonic generation, Basic elements in laser (resonator, Gain medium, Pumping technique), Characteristics of laser radiation (coherence: temporal/spatial; polarization, monochromaticity, intensity), Single mode laser (solid/ gas laser: Ruby, Nd:YAG, Ar-ion, CO_2, Excimer etc.) tunable laser (Dye laser), Harmonic generation, Application of laser (chemical problem, medicinal and industrial)

Unit-3: Quantum Mechanics-III **13M**

Quantum mechanical virial theorem and role of electronic kinetic and potential energy in the formation of covalent bonding; Hellmann-Feynman theorem. Electrostatic theorem and concept of chemical bonding; Electron spin, Exchange or permutation operator, Pauli's anti-symmetry principle, concept of spin-orbital and slater determinant, construction of ground and excited-state wavefunction of helium and lithium atom.

Unit-4: Bio-physical Chemistry **12M**

Fundamentals of biological macromolecules**:**
Protein Structure and Function: Amino acids and Peptide bond; Primary Structure; Secondary Structure-Alpha Helix, the Beta Sheet, and Turns and Loops; Tertiary Structure; Quaternary Structure; Protein-ligand interaction.
DNA: Composition; Minor groove and Major groove of DNA; Role of DNA in Transcription, DNA- ligand interaction.
Lipids and carbohydrates: Fatty Acids; Phospholipids and Glycolipids; Monosaccharides; Complex carbohydrates; Glycoproteins, Lectins.

Chemical bonds in biological systems: Properties of water; enzyme kinetics and Michaelis-Menten mechanism, thermodynamic principles in biological systems-case studies from literature, specificity and cooperativity, binding equilibrium, Hill equation and Scatchard plot.
Biophysical Methods: Stopped-flow, Gel Electrophoresis UV-vis, Circular dichroism, Differential Scanning Calorimetry, Isothermal Titration Calorimetry, Surface Plasmon Resonance, Implications in drug design.

CEM2PDSE02T **50M**

Theoretical Chemistry

Group-A **17M**

Chemical application of group theory

Crystal field splitting of free ion terms in weak and strong crystal fields (Oh and Td), energy level diagrams and symmetries and multiplicities of energy levels in strong crystal fields, correlation diagram, Tanabe-Sugano diagram. Effect of lowering of symmetry on the orbitals and energy levels, correlation table. Justification of Laporte selection rule, vibronic coupling and vibronic polarization, polarization of electronically allowed transitions. Symmetry adapted linear combinations (SALCs) and the M. O. description of organic, inorganic and organometallic molecules.

Group-B **16M**

Advanced Stereochemistry: Acyclic systems up to 4 chiral centres and their configurational descriptors. Nomenclature of compounds involving axial chirality planar chirality and helicity. Weinstein-Holness equation, Curtin Hammett principle. Conformation and reactivity of monocyclic systems- 3 to 10 member rings. 6-6, 6-5, 6-4, 5-5 bicyclic systems, 6-6-6, 6-5-6, 5-6-6-tricyclic systems. Conformational analysis of cyclohexane, cyclohexene, decalins and their derivatives.

Group-C **17M**

Advanced topics in Photophysics

Excited state proton transfer in water (illustrated with 2-Naphthols and substituted 2-Naphthols and relevant energy scheme), Relation between excited state and ground state acid dissociation constants (Derivation based on Forster cycle) and their determination from UV-Vis and Fluorescence spectra; Excited state intramolecular proton transfer; Photoinduced intramolecular charge transfer and twisted intramolecular charge transfer (discussion with suitable examples), Excimer and exciplexes, Solvent relaxation, Molecular rotors, Forster resonance energy transfer (FRET) with suitable examples and applications; Marcus theory of electron transfer (Derivation not required); Normal and inverted Marcus region.

Application Oriented Chemistry

Group-A **17M**

Spectroscopic Analysis of Inorganic Compounds and thermal analysis

Application of FT-IR, Uv-vis, Fluorescence, NMR (^{1}H, ^{13}C, ^{19}F, ^{31}P), ESR, Mossbauer spectroscopy and cyclic voltammetry in inorganic chemistry (examples with simple and complex inorganic compounds)
Solid state reactions: Kinetics of solid state reactions by TGA, DTA and DSC methods (typical examples).

Group-B **16M**

Supramolecular Chemistry: From molecular to supramolecular chemistry: Factors leading to strong binding (non-covalent interaction), New molecular receptors, Crown ether, Sidero force, Cyclophanes, Cyclodextrin and their application in specific recognition processes. Supramolecular reactivity and catalysis, Switching devices, self-assembly, supramolecular gels, self-replication, supramolecular transportation.

Group-C **17M**

Advanced Material Chemistry

Conducting Polymers: Introduction, structure and characteristics; Types of conducting polymer, conduction process in conducting polymers and concept of doping, role of polarons, bi-polarons and solitons in conduction mechanism. Chemical and electrochemical methods of synthesis of conducting polymers-Applications of conducting polymer.

Hybrid materials: Chemical synthesis of dimensionally modulated nanocomposites, core shell nanostructured materials and structures resulting from self-assembly of nanomaterials, Applications and advantages of such materials.

Nanotechnology in Drug Delivery: Introduction to Nano-mediated drug discovery and development. Drug delivery system, nanoparticles in drug delivery, Applications of lipids, CNTs, proteins, peptides. dendrimer and cyclodextrin based organic nanoparticles in nano medicine and drug delivery.

CEM2PCOR18M **50M**

Research Project

Course Specific Outcome :

Students will obtain first hand experience of pursuing research during the postgraduate course and will be able to choose independently a research problem and try to solve it successfully.

Research problem has to be finalized in consultation with the project supervisor. The work has to be carried out under the supervision of the project supervisor and a report of the work done and the data collected during the course of his study of approximately 25 pages has to be submitted. Evaluation will be carried out on the work done, methodology of analysis of problem, supervisors assessment and defense in a seminar presentation by a panel of experts.
Time allotted : 8 weeks

CEM2PCOR19M **50M**

Group-A **30M**

Literature Review-

The candidate is required to do a theoretical review of any topic of his choice in chemistry, prepare a report of the same of approximately 15 to 20 pages and present his observation in the form of a Seminar Lecture where his assessment of the review topic will be carried out by a panel of experts.

Group-B

Grand Viva Examination **20M**

Reference Books:

1. Lee J. D. Concise Inorganic Chemistry, 5th Ed., Wiley India Pvt. Ltd., 2008.
2. Douglas, B. E. and McDaniel, D. H. Concepts & Models of Inorganic Chemistry Oxford, 1970.
3. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS publications, 1962.
4. Atkins, P. Shriver & Atkins' Inorganic Chemistry, 5th Ed., Oxford University Press (2010).
5. Cotton, F.A., Wilkinson, G. and Gaus, P. L., Basic Inorganic Chemistry 3rd Ed., Wiley India. 6. Sharpe, A. G., Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005.
7. Huheey, J. E.; Keiter, E. A. &Keiter, R.L., Inorganic Chemistry, Principles of Structure and Radioactivity 4th Ed., Harper Collins 1993, Pearson, 2006.
8. Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press 2006.
9. Mingos, D.M.P., Essential trends in Inorganic Chemistry, Oxford University Press (1998).
10. Winter, M. J., The Orbitron, http://winter.group.shef.ac.uk/orbitron/ (2002). An illustrated gallery of atomic and molecular orbitals.
11. Burgess, J., Ions in solution: basic principles of chemical interactions, Ellis Horwood (1999). 12. Finar, I. L. Organic Chemistry (Vol- 1), 6th Edition, Pearson Education, 2002
13. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
14. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
15. Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited.
16. Graham Solomons, T.W. Fryhle, C. B. Organic Chemistry, John Wiley & Sons, Inc.
17. Eliel, E. L. &Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994. 18. Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, Second edition, Oxford University Press, 2012.
19. Carey, F. A., Guiliano, R. M. Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.
20. Castellan, G. W. Physical Chemistry, Narosa
21. McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach,Viva Press
22. Engel, T. & Reid, P. Physical Chemistry, Pearson
23. Levine, I. N. Physical Chemistry, Tata McGraw-Hill
24. Maron, S. &Prutton Physical Chemistry
25. Ball, D. W. Physical Chemistry, Thomson Press
26. Mortimer, R. G. Physical Chemistry, Elsevier
27. Laidler, K. J. Chemical Kinetics, Pearson
28. Glasstone, S. & Lewis, G.N. Elements of Physical Chemistry
29. Rakshit, P.C., Physical Chemistry Sarat Book House
30. Zemansky, M. W. &Dittman, R.H. Heat and Thermodynamics, Tata-McGrawHill
31. Rastogi, R. P. &Misra, R.R. An Introduction to Chemical Thermodynamics, Vikas
32. Klotz, I. M. & Rosenberg, R. M. Chemical Thermodynamics, Wiley
33. Bijan K. Paul, Introductory Notes on Quantum Chemistry, Global Net Publication.
34. Supramolecular Chemistry by Jonathon W Steed & Jerry L Atwood, Wiley
35. Fundamental of Medicinal Chemistry by Gareth Thomas, Wiley