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Semester I

Course Title	Inorganic Chemistry I
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH11**
Course Type	Core Paper
Credits	4
Marks	75

UNIT I: SOLID STATE CHEMISTRY

Crystal structure - SF_6, Fluorite, Antifluorite, Perovskite, $CdCl_2$, ~~Mg_2SiO_4, K_2NiF_4, Rh_4F_{20},~~ Spinel, Inverse Spinel and Rutile.

~~Electronic spectra of metal complexes – free ion terms and energy levels – Electron configuration, microstates – Calculation for p and d configuration, Russel Saunders (L-S coupling). Electronic spectra of $[Ti(H_2O)_6]^{3+}$, $[Cu(H_2O)_6]^{2+}$, $[V(H_2O)_6]^{2+}$.~~

~~Bragg's law and applications~~ - Electronic band structure of solids.

UNIT II: CHEMICAL BONDING, CHAINS AND RINGS

Bent's rule - Apicophilicity of dπ-pπ bonds,

M.O theory - symmetry and overlap - M.O diagram of HF and BeH_2. Walsh diagram (triatomic molecules- BeH_2 and CO_2).

Chains catenation - heterocatenation - Intercalation chemistry - One-dimensional conductors - $(SN)_x$

Rings - Preparation, properties and structure of borazine, and phosphazene.

Cages - Preparation and structure of phosphorous cage molecules, Diboranes, Styx number, tetraboranes. Structures of B_5H_9, B_5H_{11}, B_6H_{10}, $[B_8H_8]^{2-}$- Structural relationships of closo, nido and arachno boranes.

Carboranes - Structure of nido-CB_5H_9, nido-2, 3-$C_2B_4H_8$, closo-1, 5-$C_2B_3H_5$ and closo-2,4-$C_2B_5H_7$.

UNIT III: NOBLE GASES, PSEUDO HALOGENS AND INTERHALOGENS COMPOUNDS

The reactions and structure of noble gases - Structure of xenon hydrate clathrate - Bonding of xenon with fluorides - Bonding of noble gases with other compounds.

~~Pseudohalogens – Formation of pseudohalogens by oxidation, disproportionation and precipitation reactions, Electrochemistry of the pseudohalogens~~

Interhalogens - Different interhalogen compounds by oxidation states - Structure of polyhalide ions - Structure of I_2Cl_6 - Halogen oxides and oxyfluorides - Halogen cations.

UNIT IV: NUCLEAR CHEMISTRY

Thermal and nuclear reactions - Q-value, capture cross section, threshold energy and excitation functions. Types of nuclear reactions - Spallation, fission and fusion -

Fissile and fertile isotopes. Nuclear fission - Characteristics - product distribution - Nuclear fusion and stellar energy, nuclear reactions - nuclear materials and waste disposal. Radiation hazards and protection- Hydrated electrons: Hart and Boag's experiment for production hydrated electrons.

UNIT V: METAL CARBONYLS AND CLUSTERS

Metal carbonyl complexes - Preparation and properties (Ni $(CO)_4$, $Fe(CO)_5$, $Fe_2(CO)_9$, $Cr(CO)_6$, $Re_2(CO)_{10}$), Polynuclear carbonyl complexes ($Fe_3(CO)_{12}$, $Co_4(CO)_{12}$, $Os_4(CO)_{14}$,).

Carbonyl hydride complexes ($HCo(CO)_4$, $HRe(CO)_5$, $H_2Fe(CO)_4$, $[HCr(CO)_5]^-$, and $HMn(CO)_5$), Isolobal fragments.

Structure prediction for heteroboranes and organometallic clusters ($B_3H_7[Fe(CO)_3]_2$, $Rh_6(CO)_{16}$), Metal nitrosyls ($Fe(CO)_2(NO)_2$, $Co(CO)_3(NO)$, $Mn(CO)_4(NO)$, (η^5-C_5H_5)$Re(CO)_2NO]^+$ and $Co(NO)(CO)_3$)

Metal alkyls, carbenes, carbines and carbides alkyl complexes (Manganese and Iron complexes), Nonaromatic alkene (Platinum and Nickel complexes) and alkyne complexes (Cobalt complex), Allyl and pentadienyl complexes (Manganese and Nickel complexes).

Metallocenes, Molecular orbitals of Metallocenes.

Metal clusters - Dinuclear compounds (Rhenium, Molybdenum and Tungsten complexes) - Trinuclear clusters$(Re_3Cl_{12}]^{3-}$, Polyatomic zintl anions and cations.

Semester I

Course Title	Organic Chemistry I
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH12**
Course Type	Core Paper
Credits	4
Marks	75

UNIT I: REACTION INTERMEDIATES AND ELIMINATION REACTIONS

Reaction Intermediates

Generation, Structure, Stability and Reactivity - Carbocations - Carbanions - Free radicals - Carbenes and Nitrenes.

Elimination Reactions:

The E_2, E_1 and E_1CB Mechanisms, orientation of the double bond, reactivity effects, substrate structures, attacking base, the leaving group and the medium - Saytzeff rule, Pyrolytic syn-elimination, Bredt's rule and Hoffmann rule.

UNIT II: NUCLEOPHILIC SUBSTITUTION REACTIONS

Aliphatic Nucleophilic Substitution Reactions:

SN_2, SN_1 and SN_i Mechanisms, reactivity effects, substrate structure, attacking nucleophile, leaving group and reaction mediums - Neighboring group participations - Neighboring group participation by π and σ bonds - Anchimeric assistance - Phase transfer catalysis - ambient nucleophile and region selectivity.

Aromatic Nucleophilic Substitution Reactions

The SNAr, SN_1 and Benzyne Mechanisms, reactivity effects, substrate structure, attacking nucleophile, leaving group and reaction mediums - The Von-Richter - Sommelet-Hauser reaction, Sandmeyer reaction and Smile rearrangements.

UNIT III: ELECTROPHILIC SUBSTITUTION REACTIONS

Aliphatic Electrophilic Substitution Reactions

SE_1, and SE_2 Mechanisms, reactivity effects, substrate structure, attacking nucleophile, leaving group and reaction mediums and electrophilic substitution accompanied by double bond shifts

~~**Aromatic Electrophilic Substitution Reactions**~~

~~Arenium ion mechanisms, reactivity effects, substrate structure, attacking nucleophile, leaving group and reaction mediums - The ortho/para ratio - Ipso attack - Orientation and reactivity in mono-substituted benzene rings - Orientation in benzene rings with more than one substituent - Vilsmeir Haack reaction - Gattermann Koch - Reimer-Tiemann and Pechmann condensation reactions.~~

~~**UNIT IV: NAMING REACTIONS**~~

~~General nature, method, mechanism and synthetic applications of the following reactions:~~

~~**Simple Reactions**~~

~~Michael addition - Darzen's glycidic ester synthesis - Mannich reaction - Dickmann reaction - Birch reduction - Wittig reaction - Knoevanagel reaction - Stobbe condensation - Jones oxidation - Swern oxidation - Vilsmeier Haack reaction - Mitsunobu reaction.~~

~~**Coupling reactions**~~

~~Role of Palladium and Nickel catalyst in organic reactions. Both Pd(0), Ni(0) and Pd(II), Ni(II) complexes are included. Typical reaction involving Heck, Negishi, Suzuki - Miyaura, Sonogashira, Stille and Hiyama coupling for the carbon-carbon bond formation.~~

UNIT V: STEREOCHEMISTRY I

Chirality - Symmetry elements ~~- Asymmetric and Dissymmetric chiral molecules - Calculation of number of optical isomers - Stereochemistry of mono and di substituted cyclopropane, cyclobutane, cyclopentane and cyclohexane - Stereochemistry of trisubstituted cyclopentane, tri substituted pentane and tetra substituted hexane - Description of various types of optically active compounds including allenes, cumulenes, spiranes, biphenyls, trans-cyclooctene.~~

Semester I

Course Title	Physical Chemistry - I
Total hrs	75

Hrs/Week	5
Sub. Code	**21PCCH13**
Course Type	Core Paper
Credits	4
Marks	75

UNIT I CHEMICAL THERMODYNAMICS

Partial Molar quantities - partial molar volume - chemical potential - physical significance - variation of chemical potential with pressure and temperature - Gibbs Duhem equation - application - chemical potential of a pure solid or liquid and pure ideal gas - thermodynamic function and mixing of ideal gases - ΔG_{mix}, ΔS_{mix}, ΔH_{mix}, ΔV_{mix} and ΔA_{mix} Fugacity - determination of fugacity of a real gas (obeying Van der Vaals equation) - Physical significance. Activity - concept of activity - activity coefficient - Maxwell's thermodynamics relation - Applications - Thermodynamics equation of states - Applications.

UNIT II IRREVERSIBLE THERMODYNAMICS AND CHEMICAL EQUILIBRIUM

Irreversible thermodynamics: Onsager Reciprocal relation - Entropy production - Heat flow, Chemical reactions, Open systems- Flux and Force - Microscopic reversibility - Verification of Onsager's relation - Knudsen effect - application of irreversible thermodynamics to biological and non linear systems.

~~**Chemical equilibrium:** Law of Mass action – Derivation – De Donder treatment of chemical equilibrium – Thermodynamic relation for chemical affinity – Van't Hoff equation and its significance – Le Chateliars Principle.~~

~~**UNIT III CHEMICAL KINETICS I**~~

~~Expression for rate constant of Reversible reaction, Parallel reactions, Consecutive reaction, Chain reaction – Third order reactions- Expression for rate constant – Theories of reaction rates – Perrin's theory – Lindemann's Time Lag theory – Lindemann's collision mechanism – Postulates, Expression, Limitation – Activated complex theory – Hinshelwood theory – RRK theory – Marcus theory – RRKM theory.~~

~~**Unit IV CHEMICAL KINETICS II**~~

~~Kinetics of $H_2 + Br_2 \rightarrow 2HBr$ – Decomposition of acetaldehyde – Decomposition of ethane – Effect of temperature and catalyst on reaction rates – Arrhenius equation~~

→

Activation energy – effect of pressure and volume- Hammond Principle – Ter molecular reactions – $2NO + Cl_2 \rightarrow 2NOCl$.

Reactions in solution – Kinetics, Factors – Bronsted Bjerrum equation – Primary salt effect – Secondary salt effect- Significance of salt effects – effect of pressure and volume of activation.

Unit V QUANTUM CHEMISTRY I

Classical wave theory - black body radiation - Planck's quantum hypothesis - Photoelectric effect - Compton effect - Wave-particle duality - de Broglie wave equation - Uncertainty principle - Evidences, Experimental proof and Applications - Bohr's correspondence principle.

Schrodinger wave equation – Wave function – Properties, orthogonality and normalization.

Semester I

Course Title	**Photochemistry**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH1A**
Course Type	Elective Paper
Credits	4
Marks	75

UNIT I PHYSICAL PROCESSES IN PHOTOCHEMISTRY

Laws of photochemistry – Beer Lamberts law, Grotthus Draper law, Stark-Einstein law – Jablonski diagram – Internal conversion, Intersystem crossing – Fluorescence – Delayed fluorescence – P type and E type – Factors affecting fluorescence – Phosphorescence – Physical relaxation processes – Intramolecular, Intermolecular, electron transfer – Lifetime of excited states – singlet state, singlet radiactive excited state, triplet state – Franck Condon Principle.

UNIT II PHYSICAL PROPERTIES AND TECHNIQUES

Physical properties of electronically excited molecules – excited state dipole moment – excited state redox potentials – Quantum yield – Quenching- Stern Volmer equation and its applications - Experimental techniques in photochemistry - chemical actinometry, flash photolysis, Pulse methods, Phase shift method – Elementary aspects of photosynthesis.

UNIT III ORGANIC PHOTOCHEMISTRY

Thermal and Photochemical reaction – allowed and forbidden transition – Photo sensitization – Photochemistry of excited ketones (acetone, 2-hexanone, benzophenone) – Norrish type I & II reaction – Paterno Buchi reaction – Di π methane rearrangement – Photo reduction – Photochemistry of olefins – cis & trans isomerization.

UNIT IV INORGANIC PHOTOCHEMISTRY

Transition metal complexes – Excited states – Charge transfer, MLCT – Flourescence in inorganic complexes – Photosubstitution – Photoaquation, Photoanation, Photorearrangement – Geometrical isomerization, Racemization, Linkage photoisomerization, Photoexchange – Chemiluminescence in chromium and ruthenium complexes – Metallocenes – TiO_2 - Nanocrystalline, Density of unoccupied acceptor states (DOS).

UNIT V SEMICONDUCTOR PHOTOCHEMISTRY AND NANOPHOTONICS

SEMICONDUCTOR PHOTOCHEMISTRY: Photovoltaic cells – Solar energy, Conversion of solar energy – Dye sensitized conversion – Water splitting Photocatalysis – Photoinduced Superhydrophilicity.

NANOPHOTONICS: Luminescent nano diamond, Cellular imaging application – Limitations – Upconversion Nanoparticle (UCNP) – Production, characterization, Applications, Limitations.

Semester I

Course Title	Medicinal Chemistry
Total hrs	60
Hrs/Week	4

Sub. Code	**21PECH1B**
Course Type	Elective Paper
Credits	4
Marks	75

UNIT I DRUG DESIGN

~~Analogues – Prodrugs – Lead compounds – Narcotic analgesics – Antipyretic analgesics – Antirheumatic drugs – Drug design- Factors, Rational, Method of variation, Disjunction – Revolution – Molecular hybridization – Rigidity and flexibility- Tailoring – Structurally specific drug – Non specific drug – Thermodynamic activity – Meyer-Overton and Meyer-Hemmi Theory – Ferguson's theory – Vander vaals constant – The cut-off point – Steric factor – Taft's steric factor – Verloop steric parameter – Molar refractivity.~~

UNIT II MOLECULAR MODELLING AND DRUG DESIGNING

Molecular modeling - Molecular mechanics - Quantum mechanics - Charge and electrostatics - Chemical reactions modeling - Transition inhibitor - 3D structure of macromolecular targets - Structure based drug design - Major steps - Ligand receptor recognition - Active site - Electrostatic and hydrophobic fields- Design of ligands - Visually Assisted Design - Databases - Divide and Rule - Methodologies of Docking.

UNIT III GENERAL ANESTHETICS

Classification - Inhalation anesthetic - Ether, Ethyl chloride, Vinyl ether, Cyclopropane, Chloroform - Intravenous - Thiopental sodium, Ketamine hydrochloride, Thiamylal sodium - Basal anesthetics - Fentanyl Citrate, Tribromoethanol, Paraldehyde - Mode of action - Stereochemical effects - Ion channel and protein Receptor hypothesis - Mechanism.

~~UNIT IV MUSCLE RELAXANTS~~

~~Classification – Neuromuscular Blocking Drugs – Centrally Acting Muscle Relaxants – Depolarizing Neuromuscular Blocking Drugs – Centrally acting muscle relazant – Substituted Alkanediols and Analogues – Imidazoline analogue – Mechanism of action – Mode of action.~~

~~UNIT V ANTIPYRETIC ANALGESICS~~

~~Classification – Aniline and p-aminophenol analogue – Paracetamol, Phenacetin, Acetanilide – Salicylic acid analogue – Aspirin, Salol, Salsalate, Sodium salicylate, Salicylamide – Quinoline derivatives – Cincophen, Neocinchophen – Pyrazolones and Pyrazolodiones – Phenazone, Aminophenazone – N-Arylanthranilic acid – Mechanism.~~

~~Semester I~~

~~Course Title~~	~~Chemistry of Corrosion~~
~~Total hrs~~	~~60~~
~~Hrs/Week~~	~~4~~

Sub. Code	**21PECH1C**
Course Type	Elective Paper
Credits	4
Marks	75

UNIT I CORROSION

Definition – Importance – Risk management – Causes – Pilling Bed worth Ratio – Dry cell analogy – Cathode and Anode – Types of cells – Corrosion damage – Change in Gibbs free energy – Measurement of EMF, pH and Half cell potential – Hydrogen electrode – Oxygen electrode – Galvanic series – Liquid Junction Potential – Reference electrodes – Calomel, Silver Silver chloride, Saturated Copper Copper sulphate electrodes.

UNIT II THERMODYNAMICS AND KINETICS OF CORROSION

Pourbaix Diagrams – Water, Iron, Aluminium, Magnesium – Limitations – Polarization - Polarized cell - Measurement - Causes - Hydrogen overpotential - Polarization diagram – Corrosion rate – Calculation – Anode Cathode area ratio – Electrochemical Impedence Spectroscopy – Cathodic protection.

UNIT III PASSIVITY

Definition – Characteristics – Flade potential – Passivators – Iron and Nitric acid – Anodic protection and transpassivity – Theories Passive films – Passive Active cells – Critical Pitting potential – Critical Pitting temperature – Alloys – Nickel Copper alloys – Cathodic polarization and catalysis.

UNIT IV ATMOSPHERIC AND SOIL CORROSION

Atmospheric corrosion: Types of atmospheres – Corrosion product films – Factors – Particulate matter – Gases – Moisture – Remedial measures.

Soil corrosion: Factors – Bureau of standard tests – Pitting characteristics – Stress corrosion cracking – Remedial measures.

UNIT V PREVENTION OF CORROSION

Metallic coatings – Methods of application – Classification – Nickel, Lead, Zinc, Cadmium, Tin, Chromium, Aluminium – Inorganic coatings – Vitreous enamel, Portland cement, Chemical conversion – Organic coatings – Paints, Wash primer, Aluminium and zinc coating, Plastic lining.

Semester I

Course Title	Inorganic Chemistry Practical - I
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH1P1**
Course Type	Core Practical
Credits	2
Marks	50

I. Inorganic semi-micro qualitative analysis

Analysis of mixture containing two familiar and two less familiar cations
Group I less familiar Cations: W and Tl
Group II less familiar Cations: Se and Mo
Group III less familiar Cations: Zr, Ce and V
Group VI less familiar Cations: Li
Minimum 8 mixtures of inorganic compounds should have been analyzed.

II. Complexometric Titrations (A minimum of four)

1. Estimation of Copper in the presence of Lead
2. ~~Estimation of Copper in the presence of Nickel~~
3. ~~Estimation of Copper in the presence of Zinc~~
4. ~~Estimation of Copper in the presence of Iron~~
5. Estimation of Zinc in the presence of Barium

Semester I

Course Title	Physical Chemistry Practical - I
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH1P2**
Course Type	Core Practical
Credits	2
Marks	50

1. Estimation of acetic acid and sodium acetate in the buffer conductometrically.
2. Estimation of strengths of strong and weak acid in a mixture conductometrically.
3. ~~Precipitation titration of Barium chloride against Magnesium sulphate by conductometry.~~
4. Estimation of strengths of strong and weak acid in a mixture by potentiometric method
5. Determination of dissociation constant of a weak acid by potentiometric method.
6. Verification of Ostwald's dilution law.
7. Study of distribution of benzoic acid.
8. Comparison of acid strength by ester hydrolysis.
9. Adsorption of acetic acid on activated charcoal - verification of Freundlich and Langmuir isotherms, determination of unknown concentration.
10. Kinetics of persulphate - iodide reaction in solution.
11. ~~To study the effect of ionic strength on the solubility of $CaSO_4$ and so determine its thermodynamic solubility product and mean ionic activity.~~
12. ~~Avogadro software (Course work). Draw simple molecules using Avogadro software H_2O, CO_2, Acetaldehyde, Formaldehyde, methane, acetone.~~

Semester II

Course Title	**Inorganic Chemistry - II**
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH21**
Course Type	Core Paper
Credits	4
Marks	75

UNIT I: COORDINATION CHEMISTRY-I

Geometrical structure – Different coordination numbers – Coordination number 2 – Linear – $(CuCl_2]^{2-}$, coordination number 3 – Trigonal planar – $[HgI_3]^-$

Coordination number 4 – Tetrahedral – $[BeF_4]^{2-}$, $Cu[SP(Me_3)_3]^+$, $[Cu(SP(CH_3)_3)Cl]_3$, $[(CH_3CN)CuN_2C_{12}H_6(CH_3)_2]PF_6$, square planar complexes – $[Ni(CN)_4]^{2-}$ N, $[Pt(Cl)_4]^{2-}$. Coordination number 5 – Tirgonal bipyramid – $Fe(CO)_5$, $[MoCl_5]^-$, Square pyramid complexes – $[SbF_5]^{2-}$, $[Ni\{(C_6H_5)_3P\}_2Br_3]^-$. Coordination number 6 – Octahedral – $[FeF_6]^{3-}$, $[SbF_6]^-$, $[PtF_6]^-$.

Coordination number 7 – Pentagonal bipyramidal – $[UO_2F_5]^{3-}$ – Distorted octahedral – $[NbOF_6]^{3-}$ – Trigonal prism – $[TaF_7]^{2-}$. Coordination number 8 – cubic – $[UF_8]^{3-}$ – square antiprism – $[TaF_8]^{3-}$ – Dodecahedral – $[Mo(CN)_8]^{4-}$

UNIT II: COORDINATION CHEMISTRY-II

Crystal Field theory (CFT) - Important features - Effects - atomic radii - lattice energy - Geometry of coordination complexes - Crystal field Splitting of d - orbitals in octahedral, tetragonal, square planar and tetrahedral complexes - Crystal field splitting energy (CFSE) values - factors affecting the value of Δ - Application - colour, spectral and magnetic properties.

Jahn Teller Effect distortion - Effect - Electronic spectra of complexes - $[CuL_6]^{2+}$

Isomerism - Structural isomerism - $Co(NH_3)_5BrSO_4$ - Hydrate isomerism - $CrCl_3.6H_2O$ - Coordination isomerism - $[Cu(NH_3)_4][PtCl_4]$ and $[Pt(NH_3)_4][CuCl_4]$ - Linkage isomerism - $[Co(NO_2)(NH_3)_5]Cl_2$ and $[Co(ONO)(NH_3)_5]$ - Coordination position isomerism - Di-Cobalt bridged complexes.

UNIT III: COORDINATION CHEMISTRY-III

Stereo isomerism - Geometrical isomerism - Coordination number 4 - Ma_2b_2 type (cis and trans form of $[PtCl_2(NH_3)_2]$), Ma_2bc type (cis and trans form of [Pt(py)2NH3Cl]), Mabcd type ($[Pt(NO_2)(C_2H_5N)(NH_3)(NH_2OH)]^+$), $[M(ab)_2]$ type - Cis and trans form of $[Pt(gly)_2]$. Coordination number 6 - $Ma_4b_2/Ma_2b_4/Ma_4bc$ type - cis and trans form of $[CrCl_2(NH_3)_4]^+$, Ma_3b_3 type (cis and trans form of $[RhCl_3(Py)_3]$), $[M(aa)_2b]$ type (cis and trans form of $[Co(en)_2Cl_2]^+$ ion.

Substitution reactions in octahedral and square planar complexes - S_N1, S_N2, S_N1CB reaction - Labile and inert complexes - Interpretation of lability and inertness of transition metal complexes by CFT - Crystal field activation energy (CFAE) with SN1 and S_N2 reaction - Acid and base hydrolysis of octahedral complexes - Substitution reaction in square planar complexes.

UNIT IV: COORDINATION CHEMISTRY - IV

Trans effect - π bonding theory - Electron transfer reaction - Outer sphere and inner sphere mechanism.

Thermodynamic stability - Stepwise stability constant and overall stability constant. Factors affecting stability of complexes in solution - Irving-Williams series- Determination of stability constant by Bjerrum method, spectrometric method and Job's method - Comparison of thermodynamic and kinetic stability. Molecular Orbital Approach - σ and π bonding in octahedral, tetrahedral and square planar complexes - Electronic and steric effect of complexes, Symbiosis.

UNIT V: COORDINATION CHEMISTRY - V

Russell Saunders states - jj coupling, Spin-spin coupling, Orbit-orbit coupling, Spin-orbit coupling - Term symbols- Selection rule for electronic transitions - Spin selection, Laporte selection- Width of spectra- Correlation diagram - Orgel diagram - Racah parameters - Tanabe-Sugano (TS) diagram - Evaluation Δ of β and values for d^2 and d^3 systems - Electronic spectrum of d^2, d^3, d^4, d^5, d^6, d^7, d^8 and d^9 complexes- Charge transfer spectra - Ligand to Metal Charge Transfer (LMCT) - ~~Electronic spectra of lanthanides and actinides - Magnetic properties of complexes.~~

Semester - II

Course Title	**Organic Chemistry - II**
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH22**
Course Type	Core Paper
Credits	4
Marks	75

UNIT I: ~~STEREOCHEMISTRY II~~

~~Compounds containing two asymmetric centres - *Erythro* and *threo* isomers - Conversion of Fischer projection into perspective forms - *Erythro* and *Threo* Inter conversion of Fischer to Sawhorse and Newman projections - Zig-Zag representation of glucose Interpretation of homotopic, enantiotopic and diastereotopic atoms and faces - Prochiral chiral carbon -~~ R & S nomenclature of simple compounds, allenes, spiranes and biphenyls - Stereospecific and Stereoselective reactions - Asymmetric Synthesis-Crams rule - Conformational analysis of cyclohexane - Conformational analysis of di-substituted cyclohexanes.

UNIT II: OXIDATION AND REDUCTION REAGENTS

OXIDATION REAGENTS

Oxidation with Cr and Mn reagents - Oxidation with LTA, DDQ and SeO_2 - Oxidation uses DMSO either with DCC or Ac_2O or Oxalyl chloride - Oxidation using Dess Martin reagent - Hydroxylation of olefinic double bonds (OsO_4, $KmnO_4$) - Woodward and Prevost oxidation - Epoxidation using peracids including

Sharpless epoxidation, Ozonolysis.

Reduction Reagents

Reduction with $NaBH_4$, $LiAlH_4$, $Li(tBuO)_3AlH$, DIBAL-H, Red-Al, Et_3SiH and Bu_3SnH- Reduction using selectrides - Birch reduction - Hydrogenation (homogenous and heterogeneous) - hydration of carbon-carbon double and triple bonds. Asymmetric reduction of carbonyl functions (Corey's procedure).

UNIT III: NOVEL REAGENTS IN ORGANIC REACTIONS

Application of following d & p block elements in organic synthesis: Synthetic utility of Samarium iodide, Ruthenium (Ring Closing Metathesis RCM) Zirconium (Schwartz's reagent) and Cobalt (Pauson Khand reaction and Nicholas reaction) in organic synthesis - Asymmetric Reformatsky reaction using Samarium - Homogeneous hydrogenation – Application of Titanium in organic synthesis – Mc Murry coupling - Tin – in organic synthesis – Use of Bu_3SnH and Tin mediated carbon-carbon bond formation in the synthesis of cyclic and acyclic molecules.

UNIT IV MOLECULAR REARRANGEMENTS:

Mechanism of the following rearrangements: Beckmann, Curtius, Hoffmann, Schmidt, Lossen, Wolff, Pinacol, Wagner Meerwin, Demyanov, Dienone-Phenol, Favorski, Benzidine, Claisen, Cope, Sommlet-Hauser, Pummerer – rearrangements.

UNIT V PERICYCLIC REACTIONS

Electrocyclic reactions: Conrotatory and disotatory motions in (4n) and (4n+2) – allyl systems and secondary effects – Cycloadditions: Antarafacial and Suprafacial additions - Notation of cycloaddition of (4n) and (4n+2) systems - Secondary effects of substituents on the rates of cycloaddition reaction and chelotropic reactions – Sigmatropic reactions: Suprafacial and antarafacial shifts – Retention and inversion of configurations – Claisen and Cope rearrangements.

Semester - II

Course Title	**Physical Chemistry – II**
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH23**
Course Type	Core Paper
Credits	4
Marks	75

UNIT I ELECTROCHEMISTRY I

Debye-Huckel theory of strong electrolytes - derivation and verification - Activity coefficient of electrolytes - activity coefficient - ionic strength - Debye Huckel Limiting Law - derivation and verification - Determination of solute activities from solvent activities - Bjerrum's theory of ion association in electrolyte solution - Electrified

interfaces - thermodynamic treatment - electrical capacitance. Determination of the surface excess - Structure of the electric field - Helmholtz - Perrin Model, Gouy - Chapmann diffusion model and Stern Model.

UNIT II ELECTROCHEMISTRY II

Kinetics of electrode reaction - Buttler Volmer equation - Tafel equation - Diffusion over potential. Irreversible electrode process - Overvoltage - Applications - electro deposition - corrosion - Polarography - Concentration potential - DME assembly - Advantages - Ilkovic equation - Derivation - Half-wave potential - Amperometric and coloumetric titration - ~~Electrolyte concentration cells - with and without transference - EMF measurements - Activity coefficients of electrolytes, transport number, solubility product.~~

~~UNIT~~ ~~III STATISTICAL THERMODYNAMICS I~~

~~Partition functions - Translational, Rotational, Vibrational and Electronic - Relation between thermodynamic functions and partition functions - Internal energy, heat capacity, entropy, work function, enthalpy, Gibbs free energy and chemical potential - Phase space - stirlings approximation - Micro and macro states - Statistical weight factor - Configuration - Ensemble - Types - Ensemble average and time average of property.~~

UNIT IV STATISTICAL THERMODYNAMICS II

Boltzmann distribution law - ~~Kinetic theory of gases~~ - Translational kinetic energy- Translational entropy - Equipartition of energy - Statistical theory of specific heat, ~~Diatomic molecules - Rotational heat capacity for hydrogen molecule~~ - Heat capacity of solid - Types of statistics - Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac.

UNIT V QUANTUM CHEMISTRY II

Operators – Vector - Laplacian - Hermitian - Unity - Projection parity - Ladder operator and density operator.

Postulates of Quantum mechanics - Applications of quantum mechanics - 1D, 3D box - degeneracy - Tunneling - Simple Harmonic Oscillator, Rigid rotor.

Radial and Angular part of wave function - Electron spin - Wave function for hydrogen atom - Slater determinants - Angular momentum in many electron system.

Semester - II

Course Title	**~~Analytical Chemistry~~**
Total hrs	60

Hrs/Week	4
Sub. Code	**21PECH2A**
Course Type	Elective Paper
Credits	4
Marks	75

UNIT I: ~~SEPARATION TECHNIQUES~~

~~Separation techniques – Types, Principle, application – Precipitation method – separation of sulphides, hydroxides – Fractional precipitation – organic precipitation – Dimethyglyoxime, Cupferron – pH range for metal oxinates – volatilization – Determination of carbondioxide, pure silica; Electrolytic separation – metal – Controlled cathode potential – Distillation, Filtration. Solvent extraction – synergistic extraction.~~

UNIT II: **THIN LAYER CHROMATOGRAPHY**

TLC - Principle - factors affecting Rf values - Experimental Procedures - Choice of adsorbents and solvents - Preparation of plates - Development of the Chromatogram - Detection of the spots - Advantages of thin Layer Chromatography - Applications ~~- Determination of aspirin, phenacetin, caffeine mixture.~~

UNIT III: **PAPER CHROMATOGRAPHY**

Paper chromatography - Types of paper, Rf values, Factors affecting Rf values, Experimental procedures, solvent systems, developments of chromatogram - Detection of the spots. Ascending, Descending and Radial Paper Chromatography, Two-Dimensional Chromatography -Applications.

UNIT IV: THERMAL ANALYSIS

Principle, instrumentation, application - Thermo Gravimetric Analysis (TGA) - Factors affecting TGA - TGA of Calcium oxalate monohydrate

Differential Thermal Analysis (DTA) - DTA analysis of Calcium oxalate monohydrate, sulphur, polymer - Comparison of DTA and TGA curves. Differential scanning calorimetry (DSC).

UNIT V: TUBIDIMETRY, FLUOROMETRY, SPECTROPHOTOMETRY

Principle, instrumentation, applications - Turbidimetry, nephelometry, fluorometry, UV-visible spectrophotometry - single beam, double beam spectrophotometers.

Semester - II

Course Title	**Material Chemistry**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH2B**
Course Type	Elective Paper
Credits	4
Marks	75

UNIT I: CRYSTALLINE SOLIDS

Crystalline state – Crystal growth techniques- Crystal structure – archetypical industrial crystal lattice – Metalloxide lattice – Super conductivity of pervoskite – Crystal symmetric of space group – X ray diffraction – Crystal imperfection.

UNIT II: SEMICONDUCTOR

Semiconductors – Electronic band diagram – Silicon – Properties and types of semiconductors – direct and indirect gaps – carrier statistics (intrinsic and extrinsic) – Hall effect – Silicon wafer production – Silicon based applications- Superconductivity - critical parameters - Anomalous characteristics - Isotope effect, Meissner effect – Type I and II superconductors – Bardeen Cooper Schrieffer (BCS) theory – Josephson junctions and tunneling – SQUID – High temperature superconductors.

UNIT III: POLYMERIC MATERIALS

Self-assembly, self-assembled monolayers (SAMs). Langmuir Blodgett (LB) films, clusters, colloids, zeolites, organic block copolymers, emulsion polymerization, templated synthesis, and confined nucleation and/or growth. Hyper branched polymer – A_2 + B_2 hb polymer structure – Dendritic Polymers – poly(amidoamine) – polymer matrix isolation, surface templated nucleation.

UNIT IV: NANOMATERIALS

Nanotoxicity – Zero-dimensional nanomaterials – Nanoclusters ($Os_5(CO)_{16}$)- Nanoparticles – Nanopowder – Influence of size and shape on the light scattering- Preparation – Gold, silver, nanooxides (TiO_2, ZnO), bimetallic nanoparticles- Nanotube and nanwire.

Graphene – preparation, properties and applications.

UNIT V: MATERIAL CHARACTERIZATION

Principle, Theory, Working and Application – Optical microscopy – Electron microscopy – X Ray Reflectivity – High Resolution Transmission Electron Microscopy- Field Emission Scanning Electron Microscopy – Photoluminescence

Spectroscopy – Electrochemical Impedance Spectroscopy – X ray absorption fine structure (XAFS).

Semester II

Course Title	Forensic Chemistry
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH2C**
Course Type	Elective Paper
Credits	4
Marks	75

UNIT I TEXTILE AND PAINT EXAMINATION

Textile examination: Morphology - Natural, Animal, Plant, Manufactured fibers - Fiber types – Acetate, Acrylic, Aramids, Modacrylic – Instrumental analysis- Raman Spectroscopy.

Paint examination: Binders - Dyes and pigments - Additives - Forensic analysis - Microscopy, Vibrational spectrometry, SEM, EDX and XRF.

UNIT II FIRE DEBRIS AND EXPLOSIVES

Fire Debris: Sample collection – Classification – Ignitable liquids, Petroleum based liquids, Non-petroleum based liquids - sample preparation - Analysis and interpretation.

Explosives: Types – Effects – Low explosives – High explosives – Portable technology and on-screen analysis – Lab analysis – Chemical tests – X-ray analysis – SEM, EDS, Fluorescence – Spectroscopic analysis – FTIR, Raman – Chromatographic analysis – TLC, Ion and Gas, Liquid chromatography.

UNIT III SOIL AND GEOLOGIC MICROTRACES

Trace evidence - Genesis - Soil and geologic microtraces - Sample collection - Comparison – Origin, Color, Texture, Mineral – Modal analysis – Automated Instrumental Modal analysis – Ecological constituents – Anthropogenic constituents – Results.

UNIT IV FINGERMARK DETECTION

Sources – Aqueous components – Liquid components – Chemical processing – Reagents – Amino acid, Ninydrin, 1,8-Diazafluoren-9-one, 1,2-indanedione, p-Dimethylamino cinnamaldehyde - Physical developer - Lipid sensitive reagents - Oil red O, Nile red – Powder techniques – Cyanoacrylate fuming – Vacuum metal deposition.

UNIT V CHEMOMETRICS

Chromatograms and spectra - Baseline correction - Smoothing - Retention-time alignment – Normalization and Scaling – Pattern recognition – Hierarchical cluster analysis – Principle Component Analysis – k-Nearest Neighbors – Discriminant

~~Analysis- Linear, Partial Least Squares – Soft Independent Modeling – Model Validation – Applications.~~

Semester - II

Course Title	**Organic Chemistry Practical - I**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH2P1**
Course Type	Core Practical
Credits	2
Marks	50

Qualitative Analysis and Organic Preparations

I. Separation and organic qualitative analysis of the mixture containing one or two functional group. The students are expected to determine the physical constants for both the components and their derivatives.

Minimum 8 mixtures of organic compounds should have been analyzed.

II. Single step synthesis of organic compounds - isolation and purification by recrystallization of the products

~~1) Synthesis of 2-phenylindole from phenyl hydrazine (Fischer indole synthesis)~~

~~2) Preparation of benzpinacol from benzophenone~~

~~3) Nitro salicylic acid from salicylic acid (nitration)~~

~~4) Phenyl azo 2 napthol from aniline (diazotization)~~

~~5) Cannizaro reaction: Benzoic acid and Benzyl alcohol from benzaldehyde~~

~~6) Mannich Reaction: Preparation of 3 amino 1,2 diphenylpropan 1 one~~

Semester - II

Course Title	~~Analytical Chemistry Practical~~
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH2P2**
Course Type	Core Practical
Credits	2
Marks	50

I. Spectrophotometric techniques

1. ~~Determination of the concentration of unknown sodium solution by flame photometer~~
2. ~~Determination of the concentration of unknown potassium solution by flame photometer~~
3. ~~Determination of the concentration of unknown copper sulphate solution by UV-Visible spectrometer~~
4. ~~Spectrophotometric titrations for the determination of Cu(II) with EDTA~~
5. ~~Spectrophotometric titrations for the determination of Fe(III) with EDTA~~
6. ~~Determination of sulphate by turbidimetry~~.

II. Separation of mixtures (A minimum of 5 experiments)

1. Identification of amino acids (glycine, alanine, tyrosine) with the help of Paper chromatography. Calculation of R_f value of individual amino acid.
2. Identification of carbohydrates (glucose, fructose, sucrose) with the help of Thin layer chromatography. Calculation of Rf value.
3. Benzophenone and benzoic acid and checking their R_f values by TLC
4. Paper chromatographic separation of red and blue inks. Determination of R_f values.
5. Thin layer chromatographic separation of Mn and Zn. Determination of R_f values.
6. Paper chromatographic separation of Cadmium and Zinc. Determination of R_f values.

SEMESTER - III

Course Title	Organic Chemistry - III
Total hrs	75

Hrs/Week	5
Sub. Code	**21PCCH31**
Course Type	Core Paper
Credits	4
Marks	75

UNIT I: AROMATICITY AND NOVEL RING SYSTEMS

Aromaticity

Aromaticity – Huckel's rule – Five, Six, Seven and Eight membered rings, Other systems containing aromatic sexlet, Systems of two, four, six, eight, ten and more than ten electrons, Homoaromatic compounds, Syndroes and Fullerenes.

Novel rings -Nomenclature of bicyclic system - Adamantane and tricyclic systems - Cubane

Molecular machines - Catenanes, Rotaxanes, Cucurbit[n]uril - Based Gyroscane structure

UNIT II: HETEROCYCLIC CHEMISTRY

Structure synthesis and reactions of following heterocyclic compounds

Bicyclic ring systems: Indoles – Isoindoles – Benzofurans – Dibenzofurans – Quinolines – Isoquinolines – Acridines .

Five membered heterocyclic compounds with two hetero atoms:

Pyrazoles - Imidazoles - Oxazoles - Thiazoles - coumarins – flavones.

Three membered heterocyclic compounds:

Aziridine and oxirane ring systems

UNIT III: ALKALOIDS AND TERPENOIDS

Occurrence - Hoffmann, Emde and von Braun degradations - Structure elucidation of quinine, atropine and reserpine.

Classification of terpenoids with examples – isoprene rules – structural elucidations of α-pinene, Zingiberene and abitic acid.

UNIT IV STEROIDS

Total Synthesis of Steroids: Androsterone, Testosterone, Estrone, Estradiol, 2-Methoxyestradiol and Progesterone (Racemic as well as Chiral Synthesis) – Conversion of Cholesterol into steroids- Chiral as well as Racemic synthesis of Prostaglandins

PGE1, PGE2 and PGE3

UNIT V: VITAMINS

Classification, Sources, Structure and Deficiency of Vitamins - structural elucidation of Vitamins A, ~~H,~~ and E, Biosynthesis of Anthocyanin.

Semester - III

Course Title	Physical Chemistry - III
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH32**
Course Type	Core Paper
Credits	4
Marks	75

UNIT I: Group Theory I

Symmetry elements - Symmetry operations- product of symmetry operations - Symmetry point group - Determination of point group with examples - Representation of group - Matrix Notation - Great Orthogonality Theorem (GOT) - Illustration - Construction of character tables - C_{2v}, C_{3v}, C_{2h}, D_{3h}.

UNIT II: Group Theory II

Reducible representation into its irreducible representation - Rules for determining the irreducible representation of vibrational modes - normal modes of vibration of polyatomic molecules - H_2O, NH_3, BF_3 - Direct product of irreducible representation - selection rule for n-π^* and π-π^* transition in HCHO construction of Hybrid orbitals - CH_4, $[PtCl_4]^{2-}$ - secular equation in MO theory - trans 1,3-butadiene, Benzene.

UNIT III: Quantum Chemistry III

Time independent Perturbation theory - Applications to hydrogen and Helium atoms - Variation theorem - Application to hydrogen and helium atoms - Time dependent perturbation theory - Born-Oppenheimer approximation - MO theory - LCAO approximation - MO method for H_2^+ and H_2 - VB treatment of H_2 molecule - Excited state of Hydrogen molecule - Comparison of MO and VB theories.

UNIT IV: Phase rule and Colloids

Phase rule: Three component liquid systems - one, two and three pairs of partially miscible liquids - Ternary solution with common ions - Hydrate formation - Compound formation - Method of wet residue - Variation of temperature with composition - Representative point - three component system with solid phase - salting out effect.

Colloids: Preparation of lyophobic colloids - Mechanical dispersion, Electrical dispersion, Peptization - Charge on colloids - Electrical Double layer theory - DLVO theory - Applications.

UNIT V: Rotational and Vibrational Spectroscopy

Rotational Spectroscopy: Molecular rotation – Rotational spectra – Rigid diatomic molecules – Spectral line intensities – Effect of isotopic substitution – Non rigid rotator – Spectrum of non rigid molecules – Polyatomic molecules – linear, Symmetric top molecules – Asymmetric top molecules – Instrumentation – Stark effect – Application.

Vibrational Spectroscopy: Diatomic molecules- Energy – Simple Harmonic Ocsillator – Anharmonic oscillator – Selection rule- Spectrum of Carbon monoxide – Vibrational rotational interactions – Polyatomic molecules – Overtone and vibrational frequencies – Selection rule for linear molecules – Influence of nuclear spin.

Semester - III

Course Title	**Research Methodology**
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH33**
Course Type	Core Paper
Credits	4
Marks	75

UNIT: I RESEARCH FUNDAMENTALS

Objective – Criteria for good research – Choosing a research problem – Selecting, Defining – Literature survey – Primary and Secondary – Working – Experimental design Sampling, Types – problems faced – Measurement- Scaling, Tests, Techniques- Research ethics – Plagiarism – Complete Plagiarism, Source based Plagiarism, Direct Plagiarism, Self or Auto Plagiarism, Paraphrasing plagiarism, Inaccurate Authorship, Mosaic Plagiarism, Accidental Plagiarism, Plagiarism software.

UNIT: II RESEARCH WRITING AND PRESENTATION

Report writing – Types of research reports – Research paper, Short communication, Chapters in book, Review and Conference report, Project report- Research writing tools - Toggl, Phrase bank, Zotero, Trello.

Oral presentation - Power point slide preparation, Poster preparation - Writing research paper - Title, Abstract, Key words, Introduction, Methodology, Results and Discussion, Acknowledgement, Statement of conflict of interest, Cover letter, Referencing- Bibliography - Online submission of manuscripts to journals.

Pictorial tools - Mind map, Plotvar, online chart tool, Rapid tables, Chemdraw, Chemsketch.

UNIT: III DATABASE

Literature database - Scifinder, STN and Raxys - Crystallographic database - Protein databank, Cambridge Structural database – Spectral databases – NIST web book, Spectral Data Base System (SDBS), KnowItAll, Chemspider - Reactions database - chemistry. Stack exchange, Organic Synthesis, Inorganic Synthesis - Thermophysical database – NIST, Dortmund Data Bank (DDB) – Conformational database – Frog, click2drug, OMEGA, MS-DOCK – Substructure database – Molsoft, Molcart, Giga Search.

UNIT: IV STATISTICAL TOOLS

Classification of errors – Accuracy – Precision – Minimization of errors – Reliability of results – Q-test, Student's T-test, F-test, Chi-square test – Correlation coefficient – Regression – Random samples – Sampling Distribution – Confidence Intervals – T-Distribution – ANOVA in excel – Wilcoxon Signed-Rank Test – Single and Paired data - Linear Least square Analysis - ToolPak regression tool - Plotting graph for least square fit – Multiple linear regression – Origin – Data analysis, curve and surface fitting, peak analysis, statistics – Impact factor – h-index – i_{10} index.

UNIT: V IPR

Introduction – Types – Need – Protection – Copyrights, Trademarks, Designs, Utility Models, Trade Secrets, Geographical Indications – Patent and Non-patentable inventions – Patent application process – Writing document – Drafting – Filing – Legal requirements – Patent Agent – Qualification, Registration procedure – Patent offices in India – Patent databases.

Semester - III

Course Title	Spectroscopy
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH3A**
Course Type	Elective Paper
Credits	4
Marks	75

UNIT I: ELECTRONIC SPECTRA

~~Principles – selection rule - types of electron transition – chromofore – auxochrome – shifts – The Beer Lambert Law – Rotational structure of electronic and vibrational spectra~~ - Franck Condon principle - types of electronic transitions - solvent effect - blue and red shift - calculation of λ_{max} by Woodward Fieser rule and Scott rule - Applications of UV spectroscopy - calculate λ_{max} value of dienes, polyenes, carbonyl compounds and α, β-unsaturated carbonyl compounds using Woodward Fieser rule.

UNIT II: VIBRATIONAL SPECTRA

Theoretical principle - Selection rule - Harmonic oscillator- anharmonicity determination of force constant - Rotational - Vibrational spectra of diatomic molecules - P, Q, R branches - Vibrational spectra of polyatomic molecules - normal modes of vibration of CO_2, H_2O. Vibrational frequencies - Factors affecting vibrational frequencies - Finger print region - Fermi-resonance - ~~vibrational frequencies of alkanes, alkenes, aromatic compounds, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, amines, amides, nitro, nitriles, anhydrides, lactones and lactams~~.

UNIT III: NMR SPECTROSCOPY - I

^{1}H NMR: Chemical shift, Spin-spin interaction, shielding and deshielding (aliphatic, olefinic, aldehyde and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides and mercapto) - Factors affecting chemical shift - Deuterium exchange - Spin-spin coupling - factors affecting coupling constant - Complex spin-

spin interaction between two and three nuclei - Simplification of complex spectra, nuclear magnetic double resonance, contact shift reagents, solvent effects - Fourier transform technique - Nuclear Over Hauser effect (NOE). Resonance of other nuclei, Introduction and applications of ^{19}F and ^{31}P.

Multidimensional NMR spectroscopy: 2D to n-D - homonuclear coherence transfer and mixing: COSY, NOESY and TOCSY

UNIT IV: MASS SPECTROMETRY

Theory - instrumentation- Unit mass and molecular ions- singly and doubly charged ions, metastable peak, base peak, isotropic mass peaks, relative intensity and FTMS - Recognition of M+ ion peak – General fragmentation rules – Fragmentation of organic molecules – compounds containing oxygen, sulphur, nitrogen and halogens – α, β, allylic and benzylic cleavage – McLafferty rearrangement.

Various types of Mass Spectrometry: FABMS, EIMS, MALDI, ICPMS and HRMS.

UNIT V: SPECTRAL PROBLEMS

Combined problems on UV, IR, NMR and Mass spectral data for structure determination.

Elucidation of structure of organic molecules using spectra (IR & NMR).

Semester - III

Course Title	Chemistry of Milk
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH3B**
Course Type	Elective Paper
Credits	4
Marks	75

UNIT I: LACTOSE AND LIPIDS

Lactose – physical and chemical properties – Physio chemical aspects – crystallization – lactic acid fermentation – solubility – uses – Nutritional value.

Milk lipids – compositions – properties – tryglycirides – free fatty acid – compound lipids – unsaponifible matter – auto oxidation – crystallization – nucleation – crystal growth – polymorphism – compound crystal – rheological aspects.

UNIT II: PROTEINS AND ENZYMES

Chemistry of proteins definition - Casein - Precipitation of casein - Enzyme in milk – Enzyme activity – Antibacterial enzymes – Oxidoreductases – Phosphatases – Lipoytic enzymes – Proteinases – Amylases – Inactivation – Salts in milk – Composition and distribution of salt among the phases – Trace elements – Properties of salt solution – Colligative properties – Colloidal calcium phosphate – Natural components of milk – Contaminants.

UNIT III: COLLOIDAL PARTICLES OF MILK

Fat globules – Properties – Emulsion stability – Types of Instability – Coalescence – Interaction with air bubbles – High pressure milk – Raw milk – Cream and Skim milk – Lipolysis – Casein micelles – Classification of whey – Whey proteins – Heat liable – Heat stable protein – Milk as a substrate for bacteria - Pathogenic microorganisms - Spoilage microorganisms - Pathogenic organism in milk – Hygienic measure – Protection of the consumer against pathogen – Hazard analysis and critical control points (HACCP) – Quality assurance of raw milk – Milk Transport and storage - Milk chilling and storage - Membrane filtration process.

UNIT IV: CONCENTRATED MILK

Evaporated milk – Manufacture – organoleptic properties – heat stability – creamy – age thickening and gelation

Sweet and Condensed milk - Manufacture - homogenization - cooling and seeding – microbial soilage – remedies – chemical deterioration – lactose crystals.

UNIT V: TESTING OF MILK AND MILK PRODUCTS

Platform testing – organoleptic test – sediment test – clot on boiling (COB) – alcohol test – fat test – lactometer test – total solids – acidity – methylene blue reduction test (MBRT) – Phosphate – Sharer method – freezing point – microbiological test.

Semester III

Course Title	**Agricultural Chemistry**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH3C**
Course Type	Elective Paper
Credits	4
Marks	75

UNIT I PLANT NUTRITION

Biochemical functions of major nutrients – Nitrogen – Assimilation of sulphur – Deficiency - Phosphorus - Potassium - Calcium - Magnesium - Toxic effects - Carbon

and nitrogen metabolism - Carbon assimilation - Nitrogen assimilation - Senescence and nutrient cycling.

UNIT II SOIL STRUCTURE

Dynamics - Soil aggregation - Clusters - Microaggregates - Macroaggregates - Clods - Applications of Hierarchical model - Factors affecting soil aggregation - Root penetration - Moisture dynamics - Root exudates - Carbon inputs - Inorganic binding agents - Wetting and drying cycles - Clay swelling and shrinkage - Capillary forces - Soil fragmentation - Characterization of soil structure - Morphological and hydrologic properties - Stability - Imaging techniques.

UNIT III PLANT HORMONES

Auxins, Gibberellins, Cytokinins, Ascorbic acid - Biochemistry - Synthesis and transport - Physiological activities - Applications.

UNIT IV PLANT GROWTH AND DEVELOPMENT

Responses to light, Effects on photosynthesis, Phytochrome mediated responses, Temperature response, Vernalization - Atmospheric stress - Temperature, Water and Salt stress - Plant growth regulators - Morphactins - Maleic hydrazide - Glyphosine.

UNIT V WATER AND ENERGY BALANCES

Energy balance equation - Net radiation - Solar irradiance - Latent heat flux - Eddy covariance - Brown ratio - Fetch requirements - Field surface energy balance and remote sensing - Penman-Monteith estimates - Limitations - Recursive estimates - Bare soil evaporation estimates - Transpiration - Soil heat flux.

Semester - III

Course Title	Organic Chemistry Practical - II
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH3P1**
Course Type	Core Practical
Credits	2
Marks	50

I. Estimation of Organic Compounds

1. Estimation of Glucose by Bertrand's method
2. Estimation of Ascorbic acid by titration method
3. Organic estimation of citric acid
4. Estimation of Ethyl methyl ketone

II. Extraction and Recrystallization Techniques (Course Work)

1) Extraction of caffeine
2) Extraction of pigments/terpenoids-Soxhlet method
3) Recrystallization technique – Slow evaporation method

III. Organic Synthesis (Double Stage)

Exp 1: Synthesis of ethyl p-aminobenzoate (benzocaine) from p-nitro benzoic acid
Exp 2: Synthesis of Anthranilic acid from phthalic acid
Exp 3: Synthesis of m-nitro aniline from nitro benzene
Exp 4: Synthesis of m-Chloro-nitrobenzene from m-nitro aniline
Exp 5: Synthesis of Benzanilide from Benzophenone
Exp 6: Synthesis of p-bromobenzanilide from benzanilide

Semester - III

Course Title	Physical Chemistry Practical - II
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH3P2**
Course Type	Core Practical
Credits	2
Marks	50

1. Estimation of the strengths of HCl and NH_4Cl in the mixture by conductometric method.
2. Determination of dissociation constant of a weak acid conductometric method.
3. Determination of equivalent conductance of strong electrolytes at infinite dilution by conductometric method.
4. Determination of order of the saponification of an ester by half-life method.
5. Estimation of FAS by potentiometric titration.
6. Estimation of $KMnO_4$ by potentiometric titration.
7. Determination of heat of solution of naphthalene - toluene system.
8. Determination of heat of solution of oxalic acid - water system.
9. Determination of heat of solution of ammonium oxalate - water system.
10. Primary salt effect (Course Work).
11. Determination of Solubility product of Ca $(OH)_2$ at room temperature.
12. Statistical Analysis - Chi test, F-test, t-test, Regression analysis.

SEMESTER - IV

Course Title	Inorganic Chemistry - III
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH41**
Course Type	Core Paper
Credits	4
Marks	75

UNIT I: ORGANOMETALLIC CHEMISTRY-I

Organometallic compounds - Classification - metal alkyls, metal carbonyls - Group 2 elements (Be, Mg) - preparation - $(CH_3)_2BeN(CH_3)_3$, Grignard reagent, Group 12 elements (Zn, Hg, Cd) - preparation - $Zn(C_2H_5)_2$ - Group 13 elements (B) - Preparation - $(CH_3\text{-}CH_2)_3B$, - Structure - $[(CH_3)_3AlF]_4$, $[(CH_3)_3In]_4$ - Group 14 elements (Sn, Ge) - Preparation - $(C_2H_5)_3Ge\text{-}Ge(C_6H_4CH_3)_3$ - structure - $(C_2H_5)_2SnF_2$ - Group 15 elements (P) - preparation - $(CH_3)_3P{=}CH_2$ - Classification of ligands - ligand for metal-carbon bond based different electron (e^-) numbers - $1e^-$ (CH_3-Mg-Br), $2e^-$ (para alkenyl organometallics), $3e^-$ (para allylicorganometallics), $4e^-$ (para butadiene organometallics), $5e^-$ (cyclopentadienyl organometallics), $6e^-$ (cyclooctatriene organometallics), $7e^-$ (Tropilium), $8e^-$ (cyclooctatetraene organometallics).

UNIT II: ORGANOMETALLIC CHEMISTRY-II

Hapticity of organic ligands - 18 electron rule - Electron count of metal carbonyls - $Fe(CO)_5$, $Fe(CO)_9$, $Mo(CO)_6$, $Mn_2(CO)_{10}$, $[\eta^5\text{-}C_2H_5\text{-}Re\text{-}(CO)_2\text{-}C_2H_5]$, $(\pi\text{-}C_7H_7)Co(CO)_3$.

~~Bonding – Multicentre bonds – $Li(CH_3)_4$, $[Al(CH_3)_2ph]_2$, Fluxionality – Ruthacene – Bonding in π metal alkenyl complexes – Zeise's salt structure – $(K[PtCl_3(C_2H_4)]$ – Synergic effect – comparison of synergic effect in carbonyls – Binding in π metal alkynyl complexes – $[C_2ph_2Pt(PPh_3)_2]$, $[C_2(C_6H_5)_2Co_2(CO)_6]$ – Bonding in ferrocene – MO diagram.~~

UNIT III: ORGANOMETALLIC CHEMISTRY-III

Metallocenes: Synthesis, properties, structure - Bessylocene,

molybdenocene, ferrocene, magnocenes - Ferrocene aromaticity character - Nitration, Bromination, Friedel crafts reaction, Vilsmeir reaction, Mannich Condensation.

Catalysis - hydrogenation of olefins (Wilkinson's catalyst), Hydroformylation of olefins using Cobalt or Rh catalyst (oxo process), Oxidation of olefins to -CHO or –CO - (Wacker process), Polymerization (Ziegler's Natta Catalyst), Cyclooligomerization of olefins and acetylenes using Ni catalyst (Reppe's catalyst).

UNIT IV: BIOINORGANIC CHEMISTRY-I

Bioinorganic compounds – metals; Fe, Cu, Zn, Mn, Co – Metabolism – storage and transport – metal containing protein – Heme protein, Ceruloplasmin, serum albumin, zinc finger protein, super oxide dismutase, vitamin B12 – Na and K metals – chlorophyll – Homeostasis of calcium – Role of Ca^{2+} and Mg^{2+} ions – Ca pump – Na/K pump - Role of Mg^{2+} ions in energy in blood clotting - Role of H^{+}-K^{+} pump to maintain high acidity.

UNIT V: BIOINORGANIC CHEMISTRY-II

Structure and function - Metalloproteins, enzymes - Hemoglobin, myoglobin, cytochrome - O_2 binding mechanism - Heterotropic allosteric effect on O_2 - Hemerythin, hemocyanine - Oxygen uptake - Blue copper protein, superoxide dismutase (SOD) - oxygen transport mechanism - Bohr effect - Metal storage protein - Ferritin, transferrin.

Porphyrin and macrocycle rings – Aromaticity – Porphyrin, Chlorin, Baterochlorin, Corrin ring, Corphin - Flexibility of the ring.

Semester - IV

Course Title	**Advanced Organic Chemistry**
Total hrs	75
Hrs/Week	5
Sub. Code	**21PCCH42**

Course Type	Core Paper
Credits	4
Marks	75

UNIT I: RETROSYNTHETIC ANALYSIS

Disconnection approach - Basic principles of Synthons and Reagents - Synthesis of Aromatic compounds - The order of events - One group disconnections - Chemo selectivity - Two group C-X disconnection - Reversal of polarity and cyclisations - Amine synthesis - Protecting groups - One group C-C disconnections for alcohols - General Strategy A: Choosing disconnection - Stereoselctivity.

UNIT II: RETROSYNTHETIC ANALYSIS BASED REACTIONS

Synthons (acceptor and donor) - Retrosynthetic analysis - ~~Umpolung – antithesis – chiron – C-C bond forming reactions (alkylation as well as enamine alkylation) –~~ Aldol, directed aldol condensation - Michael Additions - Robinson annulations - Cycloaddition methodology in synthesis - Synthesis of cyclic structures.

UNIT III: RING SYNTHESIS AND COMPLEX MOLECULES

~~**Ring Synthesis**~~

~~Introduction to ring – saturated heterocycles – synthesis of 3,4,5 and 6 membered rings – rearrangements and photochemistry in synthesis – aromatic heterocycles.~~

~~**Complex molecules**~~

~~Synthetic routes based on retrosynthetic analysis for following molecules: Longifoline - Reserpine - Juvabione - Aphidicoline - Taxol.~~

UNIT IV: TRANSITION METAL COMPLEX IN ORGANIC REACTIONS

~~Transition metal complexes in organic synthesis; only Pd, Ni, Co, Fe (Metal mediated) C-C and C-X bond formation reactions: Heck - Stille - Fukuyama - Kumada - Hiyama - Negishi - Buchwald-Hartwig - Noyori - Reppe - and Oxo process.~~

~~C=C formation reactions: Horner-Wordworth-Emmons - Shapiro - Bamford-Stevens - McMurry and Peterson olefination reactions.~~

UNIT ~~V: REACTION AND APPLICATIONS OF FOLLOWING REAGENTS~~

~~Titanium carbene mediated olefination: Tebbe - Petasis and Nysted reagent - Multi-component reactions: Ugi – Passerini – Biginelli and Mannich reactions – Ring~~

formation reactions: Pausan Khand – Bergman and Nazerov cyclization – Metathesis: Grubbs 1st and 2nd generation catalyst, Olefin cross coupling (OCM) – ring closing (RCM) and ring opening (ROM) metathesis and applications.

Semester - IV

Course Title	**Project**
Total hrs	120
Hrs/Week	8
Sub. Code	
Course Type	
Credits	4
Marks	

Semester - IV

Course Title	**Advanced Topics in Chemistry**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH4A**
Course Type	Elective Paper
Credits	4
Marks	75

UNIT I: NANO CHEMISTRY

Background to Nanoscience - Scientific revolution - Atomic Structure and atomic size, emergence and challenges of nanoscience - Nanostructures - Carbon

Nanotubes (CNT), Graphenes, Fullerenes, Quantum Dots and Semiconductor Nanoparticles - Metal based nanostructures (nanoparticles, nanowires, nanorod) - Polymer-based Nanostructures - Coreshell, dendrimers - Applications of nanomaterials (chemical synthesis, nanomedicine). Nanoscience and Interface: Intermolecular forces, Van der Waals forces (Kessorn, Debye, and London Interactions).

UNIT II: GREEN CHEMISTRY

Green chemistry - Atom efficiency - Catalysis- Solid acids and bases- Catalytic reduction - Microwave synthesis - Electro-organic methods - Biocatalysis - Advantages in industry – Challenges - ~~Soil enrichment – Bioisosteric modification - Homogenous biocatalysis – Cyclodextrin – Green solvents – Ionic liquids – Super critical carbon dioxide - Super critical water - Industry perception - Solar energy - updraft tower – Ocean waves- hydroelectricity – Geothermal energy – Biodiesel - Biofuel.~~

UNIT III: SUPRAMOLECULAR CHEMISTRY

Supramolecular interaction - Ion-Ion, Ion-dipole, Dipole-dipole interactions - Hydrogen bonding – Cation-π, Anion-π, π-π interactions, Vanderwaals forces, closed shell interactions - ~~Hydrophobic and salvation effects – enzymes – characteristics - Mechanism - coenzyme, Biochemical self assembly chemistry - Cation binding host – Supramolecular cation coordination chemistry, Crown ether, Lariat ethers, Podanes, Cryptanes, Sphenads.~~

UNIT IV: MICROSCOPIC AND SPECTROSCOPIC CHARACTERIZATION

~~**Microscopic techniques:** Principle, Instrumentation and applications – Scanning electron microscope (SEM) – Tunneling electron microscope (TEM) – Atomic force microscope (AFM). Sample preparation for SEM, TEM, AFM analyses.~~

Spectroscopic techniques: Principle, Instrumentation and applications - Atomic absorption spectroscopy (AAS) - Photoelectron spectroscopy (PES).

~~UNIT V: MOSSBAUER SPECTROSCOPY~~

~~Physical concepts, spectral line shape, isomer shift, quadrupole splitting, magnetic hyperfine interaction – Temperature shift – Nuclear Zeeman effect – Interpretation of Mossbauer parameters of ^{57}Fe and ^{119}Sn. Applications to Solid - state reactions, thermal decomposition, ligand exchange, electron transfer and isomerism- Antiferromagnetic transition in ferrous fluoride.~~

Semester - IV

Course Title	**~~Food Chemistry~~**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH4B**
Course Type	Elective Paper

Credits	4
Marks	75

UNIT I: FOOD ADDITIVES AND CONTAMINANTS

Food additives – Vitamins, amino acids, minerals, Aroma substance flavour enhancers – monsodium glutamate, 5 nucleotides. Sugar substitutes, sorbital. Sweeteners-saccharin, cyclamate. Food colour. Anti-nutritional factors and food contaminant: Toxic trace elements, radio nuclides.

UNIT II: FOOD ANALYSIS BY CHROMATOGRAPHY TECHNIQUE

Determination of water activity in foods, Determination of level of artificial sweeteners, Determination of crude fiber in food products, Determination of Antioxidant in fruits, vegetables, Determination of polyphenols in lemon juice, Determination of fat in grains; Determination of proteins in flour, Determination of tannins in coffee/tea, caffeine content in coffee, Determination of Vitamin C, Determination of Iron , calcium in foods, Determination of Ash content in flour; Determination of total soluble solids in fruit juice, determination of reducing and non reducing sugars in food.

UNIT III: PESTICIDE RESIDUES IN FOOD

Major contaminants in food – organic contaminants – dioxins, PCBs, PCNs, veterinary drug residues, agrochemicals residues, heat generated toxicants, heavy metals and metalloids, microbiological contaminants, mycotoxins, phycotoxins plant-derived contaminants.

UNIT IV: PHYCOTOXIN

Food safety issues – origin of phycotoxin and mechanism of phycotoxin – ciguatoxin, pinnatoxin, ichthyotoxin, – food safety control of marine toxins, climate change and water toxins, and microalgae as a source of nutraceuticals.

UNIT V: MASS SPECTROMETRIC ANALYSIS

Matrix assisted laser desorption/ionization mass spectrometry imaging (MALDI MSI) – principle of MALDI MSI. Detect the food compounds in a tissue section without extraction, purification, separation or Labeling. Application of MALDI MSI.

Semester IV

Course Title	**Polymer Science**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PECH4C**
Course Type	Elective Paper
Credits	4
Marks	75

UNIT I POLYMER PROCESSING

Rheology – Processing of thermoplastics – Injection moulding – Extrusion – Blown film – Cable coating – Cast film extrusion – Mesh extrusion – Profile extrusion – Fibre spinning – Strand pelletising – Pipe extrusion – Blow moulding – Thermoforming – Rotational moulding – Processing of thermosetting polymers – Compression moulding – Transfer moulding – Injection moulding – Expanded plastics – Coating systems.

UNIT II MICROSTRUCTURE OF POLYMERS

Stereoregularity – Semi crystalline thermoplastics – Degree of crystallinity – Density method – X ray method – Infra red method – Thermal analysis method – Cross linking – Copolymer arrangements – Domain structures – Degree of molecular orientation – Briefrengence, Sonic technique, X ray method, Infra red method.

UNIT III POLYMER BEHAVIOR

Degradation – Viscoelasticity – Voigt model – Maxwell model – Shortcomings – Dynamic mechanical thermal behavior – Relaxation transitions – Molecular weight – End group analysis, Colligative property measurement, Light scattering, Ultracentrifugation, Gel Permeation chromatography – Molecular chain – Side groups – Molecular polarity – Molecular symmetry – Second glass transitions.

UNIT IV MECHANICAL PROPERTIES

Tensile properties – Effects – Testing speed and time, water absorption, Long term loading – Flexural properties – Compressive properties – Shear properties – Hardness – Impact properties and fracture toughness – Charpy test – Izod test – Falling weight test – Fracture mechanics approach – Bearing strength – Environmental stress cracking – Fatigue and wear.

UNIT V THERMAL PROPERTIES

Differential Scanning Calorimetry – Degree of crystallinity – Specific heat capacity – Oxidative induction time/temperature – Thermogravimetric analysis – Thermomechanical analysis – Time temperature superposition – Service temperature limits – Annealing and orientation – Polymer blends – Plasticizers and moisture effects – Softening temperature – Heat distortion temperature – Vicat softening temperature – Thermal conductivity.

Semester - IV

Course Title	**Inorganic Chemistry Practical - II**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH4P1**
Course Type	Core Practical
Credits	2
Marks	50

I. Gravimetric estimation and Qualitative analysis

1. Estimation of copper (V) and Nickel (G)
2. Estimation of Copper (V) and Zinc (G)
3. Estimation of Iron (V) and Nickel (G)
4. Estimation of Barium (G) and Calcium (V)

I. Complex preparation and characterization by UV-Visible spectroscopic techniques (include three)

~~1. Estimation of Cu(II) and Ni(II) -Spectrophotometric~~
2. Potassium ferrioxalate
3. Hexaammine cobalt(II) chloride
~~4. Hexaammine nickel(II) chloride~~
5. Cis-Chromiumdioxalatodihydrate
6. $[Ni(NH_3)_6]Cl_2$

Semester - IV

Course Title	**Green and ~~Nanochemistry Practical~~**
Total hrs	60
Hrs/Week	4
Sub. Code	**21PCCH4P2**
Course Type	Core Practical
Credits	2
Marks	50

General Objective:

To understand about Green Chemistry concepts in organic compounds preparation using eco-friendly starting materials and solvents.

Course Objectives: The learners will be able to:

I. Preparation of compounds using Green Chemistry

1. Synthesis of adipic acid
2. Synthesis of biodiesel
3. Preparation of benzopinacolone
4. Preparation of 1, 1-bis-2-naphthol
~~5. Preparation of 4-nitrosalicylic acid~~
~~6. Preparation of 1,5-Diphenyl penta-1,4-dien-3-0ne~~

~~**II. Preparation of compounds using Nanochemistry**~~

~~1. Synthesis of Barium nanoparticles by precipitation method.~~

2. Synthesis of zinc nanoparticles by bioreduction method.
3. Synthesis of copper nanoparticles by bioreduction method.
4. Synthesis of Iron nanoparticles by bioreduction method.

Semester - I

Course Title	**Analytical Biochemistry**
Total hrs	30
Hrs/Week	2
Sub. Code	**21PICH11**
Course Type	Interdisciplinary paper (IDC)
Credits	2
Marks	

UNIT I: PRINCIPLES OF ANALYTICAL BIOCHEMISTRY

Selection of methods – Instrumental methods – Physiological methods, Assay kits. Quality of data – errors – Random and systematic errors – Assessment – Quality assurance – Calibration – Graphical representation.

UNIT II: SPECTROSCOPY

Principle and applications of Colorimetry, Spectrophotometry and Flame Photometry.

UNIT III: SEPARATION METHODS

Rf values, Factors affecting R_f values, Experimental procedures of Thin layer Chromatography and Paper Chromatography – Choice of paper – Choice of adsorbents – solvent systems – Preparation of plates – developments of chromatogram – Detection of the spots- Applications of TLC and Paper in separation of carbohydrates and amino acids.

UNIT IV: ELECTROANALYTICAL METHODS

Principle and applications - Conductometry, Coulometry, voltammetry.

UNIT V: RADIOISOTOPES

Types of radioisotopes – detection and measurement – Geiger, scintillation – Autoradiography – biochemical uses- Traces, isotope dilution analysis, radio activation analysis.

Semester - III

Course Title	**Industrial Chemistry**
Total hrs	30
Hrs/Week	2
Sub. Code	**21PICH31**
Course Type	Interdisciplinary paper (IDC)
Credits	2
Marks	

UNIT I: PETROCHEMICALS - I

Refining of petroleum crude - Composition and uses of main petroleum fractions - ~~Heavy oil, lubricating oil, Diesel, kerosene, Petrol, Naphtha, gases – LPG, CNG. Synthetic petrol – Bergius process.~~ Cracking - Thermal Cracking, Catalytic cracking - Advantages - Spark Ignition (SI) engine for petrol vehicles - Octane number - Quality of petrol - Antiknock agents - Unleaded petrol.

UNIT II: PETROCHEMICALS - II

~~Manufacture – Amination - Pyrolysis – Esterification- Compression ignition (CI) engine~~ - Cetane number - Quality of diesel - Anti diesel knock agents - Flash point.

UNIT III: ~~FERTILIZERS~~

~~Fertilizer – Nutrient function – Micro nutrient – Fertilizer type – Need – Classification – Ammonium nitrate – Ammonium Sulphate – Phosphate fertilizer – Phosphate rock – Normal superphosphate – Effects.~~

~~UNIT IV: PESTICIDES~~

~~Pesticides – DDT, BHC, Gammexane, fumigants, Rodenticides, Fungicides, Herbicides, Synthetic insecticides, Pesticides pollution, Persistent pesticides, Biodegradation of pesticides.~~

~~UNIT V: FOOD ADULTERATION~~

~~Definition – Types – Common food adulterants – Causes, Effects, Prevention and Detection.~~