RKDF UNIVERSITY RANCHI

MASTER OF SCIENCE (M.Sc.)
APPLIED CHEMISTRY

SEMESTER I

Course	Subject Title	Subject Code
M.Sc. Chemistry	Inorganic Chemistry-I	PCH101

Unit 1

Metal-Ligand Equilibrium in Solution:

Stepwise and overall formation constants and their interaction, trends in stepwise constant, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand. Chelate effect and its thermodynamic origin, determination of binary formation constants by potentiometry and spectrophotometry.

Unit 2

Reaction Mechanism of Transition Metal Complexes I:

Energy profile of a reaction, reactivity of metal complex, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage.

Unit 3

Reaction Mechanism of Transition Metal Complexes II:

Mechanism of the substitution reaction in tetrahedral, square planar, trigonal bipyramidal, square pyramidal and octahedral complexes, the trans effect,. Redox reaction, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions.

Unit 4

Stereochemistry and Bonding in Main Group Compounds:

VSEPR, Walsh diagrams (tri-atomic molecules of type AH_2), dp-pp bonds, Bent rule and energetic of hybridization, some simple reactions of covalently bonded molecules, Atomic Inversion, Berry Pseudorotation.

Unit 5

HSAB Theory:

Classification of HSAB, HSAB principal, uses of HSAB principal,theoretical basis of hardness and softness; Lewis –acid base reactivity Approximation; donor accepter number, symbiosis.

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
3. Chemistry of the Elements. N.N. Greenwood and A. Earnshow, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Organic Chemistry-I**	**PCH102**

Unit 1

Structure and Reactive Intermediates:

Localised and delocalised covalent bond, Conjugation, Resonance, Hyperconjugation, nature of reaction energy and kinetic considerations - types of organic reactions - reagents - reactive intermediates (carbocations, carbanions, free radicals, carbenes, nitrenes, arynes), their formation and stabilization - inductive and mesomeric effects, The Hammett equation- linear free energy relationship, Taft equation, steric effects, strain and Bredt rule.

Unit 2

Streochemistry:

Absolute and relative configuration, The terms chiral, achiral, stereogenic center (stereocenter), representations of three dimensional molecules, stereoisomerism resulting from more than one stereogenic unit, Pi-diastereoisomerism and torsional chirality in carbon-carbon double bonds, some stereochemical reactions near a stereocenter (formation of diastereomers) stereoselective and stereospecific reactions, stereoisomerism in compounds without a stereogenic carbon (biphenyl, allene, catenanes, spiranes), atropiomerism, optical activity due to stereoplane (planar chirality)- paracyclophanes and transcyclooctene, optical activity of compounds due to helicity, asymmetric synthesis.

Unit 3

Aromaticity:

Concept of aromaticity - Huckel's rule for aromaticity in benzenoid and non-benzenoid compounds, antiaromaticity and homo-aromaticity., aromatic compounds, antiaromatic compounds, nonaromatic compounds, annulenes, ions, metallocenes, Crown ether complexes and cryptates.

Unit 4

Aliphatic Nucleophilic Substitution:

S_N1 , S_N2, mixed S_N1 and S_N2 reactions, S_N2 reaction as a stereospecific reaction, S_N1 Mechanism-Ion Pairs and other aspects, S_Ni and SET mechanisms, neighbouring group participation, anchimeric assistance, non-classical carbocations, Conformations and stereoisomerism of acyclic and cyclic systems, conformation and chemical Reactivity. reactivity effects of substrate structure, attacking nuclephile, leaving group and reactiin medium, phase transfer catalysis, ambident nucleophiles.

Unit 5

Aliphatic Electrophilic Substitution:

Elecrophilic reactivity, general mechanism. Bimolecular mechanisms- S_E2 and S_Ei. The S_E1 mechanism, Effect of substrates,leaving group and the solvent polarity on the reactivity.

Kinetic of S_E2-Ar reaction. Structural effects on rates and selectivity.

Books Suggested:

1. J. March., Advanced Organic Chemistry: Reactions, Mechanisms and Structure, John Wiley
2. P. S. Kalsi. Stereochemistry, Conformation and Mechanism, New Age International
3. Peter Sykes, A guide book to mechanism in Organic chemistry, Orient-Longmans

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Physical Chemistry-I**	**PCH103**

Unit 1

Introduction to Exact Quantum Mechanical Results:

The Schrodinger equation and the postulates of quantum mechanics. Linear and Hermitian operators, Discussion of solutions of the Schrodinger equation to some model systems viz., particle in a box, the harmonic oscillator,the rigid rotor, the hydrogen atom. Hydrogen Molecule. Angular momentum operators, Eigenvalues and eigen-functions

Unit 2

Molecular Orbital Theory:

Huckel theory of conjugated systems bond and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical cyclobutadiene. Introduction to extended Huckel theory.

Approximate Methods**:** Variational and perturbation methods. Applications of

variation method and perturbation theory to the Helium atom.

Unit 3

Chemical Thermodynamics:

Basic concepts of laws of thermodynamics, free energy, chemical potential and entropy. Partial molar Quantities: Partial molar free energy, partial molar volume and partial molar heat content, Non-ideal systems : Excess functions for non-ideal solutions. Activity, activity coefficient, Debye Huckel theory for activity coefficient for electrolytic solutions; Determination of activity and activity coefficient; ionic strength, Gibb's Duhem equation, Nernst heat theorem, Maxwell's thermodynamic relation.

Unit 4

Statistical Thermodynamics:

Partition functions-translation, rotational, vibrational and electronic partition functions. Calculation of thermodynamic properties in terms of partions. Heat capacity behaviour of solids- chemical equilibrium and equilibrium constant in terms of partition functions, Fermi-Dirac Statistics and Bose-Einstein statistics distribution law and application to helium.

Unit 5

Macromolecules:

Molecular weight of a polymer (Number and mass average) Degree of polymerization and molecular weight, methods of determining molecular weights (Osmometry, viscometry, light scattering, diffusion and ultracentrifugation)Chemistry of polymerization.

Mechanism of polymerization , Free radical polymerization (Initiation, propagation and termination), kinetics of free radical polymerization, step growth polymerization (Polycondensation), kinetics of step polymerization, cationic and anionic polymerization.

Books Suggested:

1. J. P. Lowe and K.Peterson, Quantum Chemistry Academic Press.
2. D. A. McQuarrie, Quantum Chemistry Viva Books Pvt. Ltd.: New Delhi.
3. R. G. Mortimer, Mathematics for Physical Chemistry Elsevier.
4. F. L. Pilar, Elementary Quantum Chemistry , Dover Publication Inc.: New York.

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Group Theory and Spectroscopy**	**PCH104**

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Unit 1

Symmetry and Group Theory:

Symmetry elements and symmetry operation, definition of group, subgroup. Conjugacy relation and classes. Point symmetry group. Schonfilies symbols,

representations of groups by matrices (representation for the C_n, C_nv, C_nh, etc, group to be worked out explicitly). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their use; spectroscopy. Derivation of character table for C_2v and C_3v point group Symmetry aspects of molecular vibrations of H_2O molecule.

Unit 2

Rotational Spectroscopy:

Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor. Stark effect, nuclear and electron spin interaction and effect of external field.

Unit 3

Vibrational Spectroscopy:

Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strengths; anharmonicity, Morse potential energy diagram, vibration-rotation spectroscopy. P.Q.R. branches, Breakdown of Oppenheimer approximation; vibrations of polyatomic molecules. Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intercities, far IR region, metal ligand vibrations, normal co-ordinate analysis. Symmetry, shapes and molecular vibrations of AB_2, AB_3, AB_4, AB_5 and AB_6.

Unit 4

Raman Spectroscopy:

Classical and quantum theories of Raman effect. Pure rotational, vibrational and vibrational rotational Raman spectra, selection rules, mutual exclusion principle, Resonance aman spectroscopy, coherent anti stokes Raman spectroscopy (CARS).

Unit 5

Molecular Spectroscopy:

Energy levels, molecular orbitals, vibronic transitions, vibrational progressions and geometry of the excited states, Franck-Condon principle, electronic spectra of polyatomic molecules. Born- Oppenheimer approximation. Emission spectra; radiative and non-radiative decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra.

Books Suggested:

1. Modern Spectroscopy, J.M. Hollas, John Viley.
2. Applied Electron Spectroscopy for chemical analysis d. H. Windawi and F.L. Ho, Wiley Interscience.
3. NMR, NQR, EPr and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis
4. Physical Methods in Chemistry, R.S. Drago, Saunders College.

Course	Subject Title	Subject Code
M.Sc. Chemistry	Practical-I	PCH155

A. Inorganic Chemistry

1. Chromatography: Separation of cations and anions by Paper Chromatography.

2. Preparations: Preparation of selected inorganic compounds and their studies by I.R. electronic spectra, Mossbauer, E.S.R. and magnetic susceptibility measurements.

3. Qualitative Analysis: Separation, purification and identification of compounds of binary mixture (one liquid and one solid) using TLC and columns chromatography, chemical tests. IR spectra to be used for functional group identification.

B. Organic Chemistry

1. Organic Synthesis: (a) Acetylation : Acetylation of cholesterol and separation of cholesteryl acetate by column chromatography.

(b) Oxidation : Adipic acid by chromic acid oxidation of cyclothexaneol

(c) Grignard reaction : Synthesis of triphenylmethanol from benzoic acid. The Products may be Characterized by Spectral Techniques.

2. Drug Analysis

C. Physical Chemistry

1. Error Analysis and Statistical Data Analysis: Errors, types of errors, minimization of errors distribution curves precision, accuracy and combination; statistical treatment for error analysis, student 't test, null hypothesis, rejection criteria. F & Q test; linear regression analysis, curve ftting. Calibration of vlumetric apparatus, burette, piette and standard flask.

2. Adsorption: To study surface tension-connectration relationship for solutions (Gibbs equation). Phase Equilibria

3. Chemical Kinetics: (a) Determination of the effect of (i) Change of temperature (ii) Charge of concentration of reactant and catalyst and (iii) Ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reaction.

(b) Determination of the velocity constant of hydrolysis of an ester/ionic reaction in micellar media.

(c) Determination of the velocity constant for the oxidation of iodide ions by hydrogen peroxide study the kinetics as an iodine clock reactions.

4. Solution: (a) Determination of molecular weight of non-volatile and electrolyte/electrolyte by cryoscopic method and to determine the activity coefficie nt of an electrolyte.

(b) Determination of the degree of dissociation of weak electrolyte and to study the deviation from ideal behaviour that occures with a strong electrolyte.

Books Suggested:

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R.C. Denney, G.H. Jeffery and
J. Mendham, ELBS.
2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly. Prentice Hall.

RKDF UNIVERSITY RANCHI

MASTER OF SCIENCE (M.Sc.)
APPLIED CHEMISTRY

SEMESTER II

Course	Subject Title	Subject Code
M.Sc. Chemistry	Inorganic Chemistry-II	PCH201

Unit 1

Electronic Spectra of Transition Metal Complexes:

Term-symbols, Russel-Saunders states, Crystal field theory and splitting in *Oh*, *Td*, *D4h* and *C4v* systems, Spectroscopic ground states, correlation. Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), calculations of 10Dq, B and β parameters, charge transfer spectra, anomalous magnetic moments, Orbital contribution to magnetic moment, magnetic exchange coupling and spin crossover.

Unit 2

Metal π-Complexes:

Metal carbonyl, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding structure and important reaction of transition metal nitrosyl, dinitrogen and dioxgen complexes; tertiary phosphine as ligand.

Unit 3

Magnetic Properties of Transition Metal Complexes:

Type of magnetic bodies, two sources of paramagnetism, orbital and spine effect, curic equation and curic wies law, determination of magnetic susceptibility, magnetic properties of transition metal complexes and lanthanides

Unit 4

Boranes:

Classification, preparation, reactivity, bonding and topology of Boranes, carboranes, metalloboranes and metallocarbonaes. Metal Clusters, Chains and Fullerenes Compounds with metal-metal multiple bonds. Isopoly and heteropoly acids and their salts. Fullerenes

Unit 5

Metal-Ligand Bonding:

Molecular orbital theory and p-bonding. Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes.

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
3. Chemistry of the Elements. N.N. Greenwood and A. Earnshow, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
5. Magnetiochemistry, R.1. Carlin, Springer Verlag.
6. Comprehensive Coordiantion Chemistry eds., G. Wilkinson, R.D. Gillars and J.A. Mc Cleverty,Pergamon.

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Organic Chemistry-II**	**PCH202**

Unit 1

Common Organic Reactions:

Common organic reactions and their mechanisms base catalysed reactions, Stork Enamine reaction, acid catalysed reactions, reactions of carboxylic acids and their derivatives. Mechanism of condensation reactions involving enolates- Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters Stereochemistry and mechanism of addition to carbon-carbon multiple bonds, addition reactions of alkenes and alkynes involving electrophiles, Birch reduction, epoxidation of alkenes Addition to carbon-hetero multiple bonds, addition to carbonyl compounds, metal hydride reduction, Meerwein-Ponndorf-Verley reduction, Wittig reaction, Hydroboration. Michael reaction.

Sharpless asymmetric epoxidation. Elimination reactions

Unit 2

Reagents in Organic Synthesis:

Organo transition metal reagents, some transition metal organometallic reactions, organozinc, organolithium reagents. phosphorus containing reagents, organosulphur compounds, silicon reagents, boron containing reagents.

Applications of Pd(0) and Pd(II) complexes in organic synthesis: Stille, Suzuki and Sonogashira coupling, Heck reaction and Negishi coupling.

Hydride transfer reagents: Sodium borohydride, sodium cyanoborohydride, lithium aluminium hydride and alkoxy substituted LAH reducing agents, DIBAL; Applications of hydroboration (reductions, oxidations and cabonylations): diborane, diisoamylborane, thexylborane, 9-BBN, isopinocamphenyl and diisopinocamphenyl borane. Hydrogenation (Rh, Ru and

other metal complexes), oxidation [DDQ, SeO_2, $Tl(NO_3)_3$].

Unit 3

Aromatic Substitution:

Aromatic Electrophilic substitution: The arenium ion mechanism, orientation and reactivity, Ipso substitution, aromatic rearrangements, Diazo coupling, Vilsmeir reaction, Gattermann-Koch reaction.

Aromatic nucleophilic substitution: S_NAr mechanism, S_N1 mechanism, benzyne mechanism. Reactivity - effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

Unit 4

Pericyclic Reactions:

Electrocyclic reactions Conrotatory and disotatory motions (4n) and (4n+2), cycloaddition, sigmatropic rearrangements, chelotropic reactions, the ene reaction, 3-dipolar additions, Mobius-Huckel analysis (PMO approach), correlation diagram method. Sigmatropic shift involving carbon moieties, retention and inversion of configurations, (3,3) and (5,5) sigmatropic rearrangements detailed treatment of Claisen and Cope rearrangements fluxional tautomerism, aza-Cope rearrangements.

Unit 5

Photochemistry:

Photophysical processes: Jablonskii diagram, energy pooling, exciplexes, excimers, photosensitization, quantum yield, solvent effects, Stern-Volmer plot, delayed fluorescence, etc. Photochemistry of alkenes: cis-trans isomerization, rearrangements of 1,3-, 1,4- and 1,5-dienes; dimerizations.

Photochemistry of carbonyl compounds: Norrish type I & II reactions (cyclic and acyclic); α,β- unsaturated ketones; β,γ-unsaturated ketones; cyclohexenones (conjugated); cyclohexadienones (cross-conjugated & conjugated); Paterno–Buchi reactions; photoreductions.

Photochemistry of aromatic compounds: Isomerizations, skeletal isomerizations, Dewar and prismanes in isomerization. Singlet oxygen reactions; Photo Fries rearrangement of ethers and anilides; Barton reaction, Hoffman-Loefller-Freytag reaction.

Books Suggested:

1. J. March., Advanced Organic Chemistry: Reactions, Mechanisms and Structure, John Wiley
2. P. S. Kalsi. Stereochemistry, Conformation and Mechanism, New Age International
3. Peter Sykes, A guide book to mechanism in Organic chemistry, Orient-Longmans
4. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Macmillan

5. F. A. Carey and R. J Sundberg, Advanced Organic Chemistry, Part A and B, Plenum
6. K.K. Rothagi-Mukheriji, Fundamentals of photochemistry, Wiley-Eastern
7. A. Cox and T. Camp, Introductory Photochemistry, McGraw Hill.

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Physical Chemistry-II**	**PCH203**

Unit 1

Chemical Dynamics:

Chemical kinetics: Empirical rate laws, Arrhenius equation, theories of reaction rates, determination of reaction mechanisms. Kinetics of inorganic mechanisms : Hydrogen- Bromine reaction, Hydrogen- Chlorine Reaction. Decomposition of nitrogen pentaoxide, Decomposition of Ozone. Kinetics of organic decompositions : Pyrolysis of acetaldehyde, decomposition of ethane. Factors affecting reaction rates in solution. Effect of solvent and ionic strength
(primary salt effect) on the rate constant.
Collision theory. Transition state theory (both thermodynamic and statistical mechanics formulations). Theory of unimolecular reactions, Lindemann mechanism, Hinshelwood treatment, RRKM model (qualitative treatment).

Unit 2

Surface Chemistry and Catalysis:

Adsorption : Gibbs adsorption isotherm, BET equation and estimation of surface area. Micelles:Surface active agents, classification of surface active agents, micellization, critical micellar concentration (CMC), factors affecting the CMC of surfactants, thermodynamics of micellization, solubilization, microemulsions, reverse micelles, surface films (eletrokinetic phenomena)
Concepts of catalysis: Homogenous catalysis, kinetics of enzyme reactions, catalytic activity at surfaces.

Unit 3

Complex and Fast Reaction:

Complex Reactions: Opposing reactions, Complex reactions, Parallel reactions, kinetics of free radical polymerization. Fast reactions: Experimental techniques for fast reactions viz., flow method, relaxation method, flash photolysis.

Unit 4

Electrochemistry:

Electrochemistry: Electrochemical cells, Nernst equation, electrode kinetics, electrical double layer, Debye-Hückel theory. Voltammetry, Current voltage relationship,

characteristics of DME, half-wave potential. Amperometric titrations Activity coefficients and ion-ion interactions.
Corrosion: Introduction to corrosion, forms of corrosion, Corrosion monitoring and prevention Methods.

Unit 5

Non equilibrium thermodynamics:

Thermodynamics criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equation for different, irreversible processes (e.g., heat flow ,chemical reaction). Transformation of the generalized fluxes and forces, non equilibrium stationary states.

Books Suggested:

1. P.W. Atkins , Physical Chemistry, ELBS.
2. A.K. Chandra, Introduction to Quantum Chemistyry, Tata Mc Graw Hill.
3. Ira N. Levine, Quantum Chemistry, Prentice Hall.

K.J. Laidler, Chemical Kinetics. McGraw-Hill.

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Magnetic Resonance and Spectroscopy**	**PCH204**

Unit 1

Nuclear Magnetic Resonance Spectroscopy:

Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift and its measurements, factors, influencing chemical shift, deshielding, spin-spin interactions, factors influencing coupling constant "j" Classification (AXB, AMX, ABC, A_2B_2 etc.). spin decoupling; basic ideas about instrument, NMR studies of nuclei other than protin-^{13}C, ^{19}F and ^{31}P.
Carbon-13 NMR Spectroscopy: General considerations, chemical shift (aliphatic olefinic, alkyne, aromatic, heteroaromatic and carboynl carbon), coupling constants.
Two dimensional NMR spectroscopy: COSY, HETCOR, NOESY, DEPT, HMBC and HMQC techniques

Unit 2

Electron Spin Resonance Spectroscopy:

Basic principles, Hyperfine coupling, Isotropic and anisotropic hyperfine coupling contstnats, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of gtensors,factors affecting the 'g' value. Zero field splitting and Kramer's degeneracy, spin Hamiltonian, spin densities and Mc Connell relationship.

Applications.

Unit 3

Infrared Spectroscopy:

Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids,anhydrides,lactones, lactams and conjugated carbonyl compounds). Effect of hydrogen bondingand solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance.

Unit 4

Mass Spectrometry:

Introduction, ion production EI, CI, FD, ESI and FAB, ion analysis, ion abundance, Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, Mc Lafferty rearrangement , Nitrogen rule, High resolution mass spectrometry.

Unit 5

Ultraviolet and Visible spectroscopy:

Fundamentals**,** effect of solvent and extending conjugation on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Fieser Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic compounds. Steric effect in biphenyls.

Book Suggested:

1. Physical Methods for Chemistry, R.S. Drago, Saunders Compnay.
2. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS.

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Practical-II**	**PCH251**

A. Inorganic Chemistry

1. **Chromatography:** Separation of cations and anions by Column Chromatography : Ion exchange.
2. **Preparations:** Preparation of selected inorganic compounds and their studies by I.R. electronic spectra, Mossbauer, E.S.R. and magnetic susceptibility measurements. Handling of air and moisture sensitive compounds.

B. Organic Chemistry

1. **Organic Synthesis:** (a) Aldol condensation- Dibenzal acetone from benzaldehyde.

(b) Sandmeyer reaction- p-Chlorotoluene from ptoluidine

(c) Acetoacetic ester Condensation- Synthesis of ethyl-nbutylacetoacetateby

A.E.E. condensation.

(d) Connizzaro reaction : 4-Chlorobenzaldehyde as substrate

(e) Friedel Crafts reaction- β-Benzoyl propionic acid from succinic anhydride and benzene

(f) Aromatic electrophilic substitution- Synthesis of p-nitroaniline and pbromoaniline. The Products may be characterized by Spectral Techniques.

2. Quantitative Analysis: (a) Determination of the percentage or number of hydroxyl groups in an organic compound by acetylation method.

(b) Estimation of amines/phenols using bromate bromide solution/or acetylation method.

(c) Determination Determination of DO, COD and BOD of water sample.

C. Physical chemistry

1. Conductometry: (a) Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometrically.

(b) Determination of solubility and solubility product of sparingly soluble salts e.g. $PbSO_4$, $BaSO_4$ conductometrically.

(c) Determination of the strength of strong and weak acid in a given mixture conductometrically.

(d) To study of the effect of solvent on the conductance of $AgNO_3$/acetic acid and to determine the degree of dissociation and equilibirum constant in different solvents and in their mixtures (DMSO, DMF, dioxane, acetone, water) and to test the validity of Debye- Huckel-Onsager theory.

2. Potentiometry/pH metry: (a) Determination of the valency of mercurous ions potentiometrically.

(b) Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter.

(c) Determination of temperature dependence of EMF of a cell.

(d) Determination of the formation constant of silver-ammonia complex and stoichiometry of the complex potentiometrically.

(e) Acid-base titration in a non-aqueous media using a pH meter.

(f) Determination of activity and activity coefficient of electrolytes.

3. Polarimetry: Determination of rate constant for hydrolysis/inversion of sugar using a polarimeter**.**

Books Suggested:

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R.C. Denney, G.H. Jeffery and
   J. Mendham, ELBS.
2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly. Prentice Hall.

RKDF UNIVERSITY RANCHI

MASTER OF SCIENCE (M.Sc.)
APPLIED CHEMISTRY

SEMESTER III

Course	Subject Title	Subject Code
M.Sc. Chemistry	Bioinorganic Chemistry	PCH301

Unit 1

Electron Transfer in Biology:

Structure and function of metal of proteins in electron transport processes cytochrome's and Ion sulphure proteins, synthetic models. Biological nitrogen fixation, and its mechanism, nitrogenase, Chemical nitrogen fixation.

Unit 2

Metalloporphyrins:

Structure and optical spectra; heme proteins: magnetic susceptibility, epr and electronic spectra; hemoglobin and myoglobin: molecular structures, thermodynamics and kinetics of oxygenation, electronic and spatial structures, synthetic oxygen carriers, model systems; iron enzymes, peroxidase, catalase and cytochrome P-450.

Unit 3

Metalloenzymes

Copper enzymes, superoxide dismutase, cytochrome oxidase and ceruloplasmin; Coenzymes; Molybdenum enzyme: xanthine oxidase; Zinc enzymes: carbonic anhydrase, Vitamin B_{12} and B_{12} coenzymes; Ironstorage, transport, biomineralization and siderophores, ferritin and transferrins.

Unit 4

Metal Ions in Biological Systems:

Bulk and trace metals with special reference to Na, K, Mg, Ca, Fe, Cu, Zn, Co, and K+/Na+ pump. Role of metals ions in biological processes.

Unit 5

Enzymes:

Introduction, Nomenclature and classification, concept and identification of active site by use of inhibitors, reversible & irreversible inhibition.

Mechanism of Enzyme action: Transition state theory, Orientation and steric effect, acid-base catalysis, covalent catalysis.

Co-Enzyme Chemistry: Cofactors as derived from vitamins, coenzymes, prosthetic groups,

apoenzymes, Structure and biological functions of coenzyme A.

Books Suggested:

1. J. Lippard & J. M. Berg. *Principles of Bioorganic Chemistry,* Panima Publ. Corpn. (2005).
2. E.-I. Ochiai. *Bioinorganic Chemistry – An Introduction,* Allyn and Bacon Inc. (1977).
3. M. N. Hughes. *The Inorganic Chemistry of Biological Processes,* Wiley (1981).
4. R.P. Hanzlik. *Inorganic Aspects of Biological and Organic Chemistry,* Academic Press

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Environmental Chemistry**	**PCH302**

Unit 1

Environment:

Introduction. Composition of atmosphere, vertical temperature, temperature inversion, heat budget of the earth, atmospheric system, vertical stability atmosphere, Biochemical cycles of C, N, P, S and O. Biodistribution of elements.

Unit 2

Hydrosphere:

Chemical composition of water bodies-lakes, streams, rivers and wet lands etc. Hydrological cycle Aquatic pollution – Inorganic,organic, pesticide, agriculture, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters – dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate,nitrate and microorganisms.

Water quality standards: Analytical methods of measuring BOD, DO, COD, F, Oils, metals (As, Cd, Cr, Hg, Pb, Se etc.), residual chloride and chlorine demand.Purification and treatment of water. **Soils** Composition, micro and macro nutrients, pollution – fertilizers, pesticides, plastics and metals. Waste treatment.

Unit 3

Atmosphere:

Chemical composition of atmosphere – particles, ions and radicals and their formation. Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, O and their effect, pollution by chemicals, petroleum, minerals, chlorofluorohydrocarbons. Greenhouse effect, acid rain, air pollution controls and their chemistry. Analytical methods for measuring air pollutants. Continuous monitoring instruments.

Unit 4

Industrial Pollution:

Cement, sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, metallurgy.

Polymers, drugs etc. Environmental disasters – Chernobyl, Three-mile island, Seveso and minamata disasters,

Japan tsunami

Unit 5

Environmental Toxicology:

Toxic heavy metals: Mercury, lead, arsenic and cadmium. Causes of toxicity. Bioaccumulation, sources of heavy metals. Chemical speciation of Hg, Pb, As, and Cd. Biochemical and damaging effects.

Toxic Organic Compound: Pesticides, classification, properties and uses of organochlorine and ionospheres pesticides detection and damaging effects.

Books Suggested:

1. Environmental Chemistry, S.E. Mahan, Lewis Publishers.
2. Environmental Chemistry, Sharma & Kaur, Krishna Publishers.
3. Environmental Chemistry, A.K. De, Wiley Eastern
4. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Bioorganic Chemistry**	**PCH303**

Unit 1

Cell structure and Functions:

Structure of prokaryotic and eukaryotic cells, intercellular organelles and their function comparison of plant and animal cells. Overview of metabolic processes -catabolism and anabolism.

ATP – the biological energy currency. Origin of life –unique properties of carbon. Chemical evolution and rise of living systems.

Unit 2

Carbohydrates:

Structure and function of important derivatives of monosaccharides like glycosides deoxy sugars, myoinositol, amino sugars. N-acetylmuramic acid. Sialic acid. Structural polysaccharide: Cellulose and chitin.

Storage polysaccharide: Starch and glycogen. Structural and biological functions of glycosaminoglycans or mucopolysaccharides. Carbohydrates of glycoprotein and glycolipids. Role of sugars in biological recognition. Carbohydrate metabolism-Kerb's cycle, glycolysis, glycogenesis and glycogenolysis, gluconeogenesis, pentose phosphate pathway.

Unit 3

Lipids:

Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerol phospholipids, sphingolipids, Lippoproteins: Composition and function, role in atherosclerosis. Properties of lipids aggregates-micelles, bilayers, liposomes and their possible biological functions. Lipid metabolism- - oxidation of fatty acids.

Unit 4

Amino acids and Proteins:

Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins, α-helix, β-sheets. Super secondary structure, triple helix

structure of collagen. Tertiary structure of protein-folding and domain structure. Quaternary structure. Amino acid metabolism-degradation and biosynthesis of amino acids, sequence determination: chemical/ enzymetic/ mass spectral, recemization/detection. Chemistry of oxytocin and tryptophan releasing hormone (TRH).

Unit 5

Nucleic Acid:

Chemical and enzymatic hydrolysis of nucleic acids. Structure of ribonucleic acids (RNA) and deoxyribonucleic acids (DNA) double helix model of DNA and forces responsible for holding it. The chemical basis for heredity, an overview of replication of DNA, transcription, translation and genetic code.

Chemical synthesis of mono and trinucleoside.

Books Suggested:

1. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
2. Biochemistry, L. Stryer, W.H. Freeman.
3. Biochemistry, J.David Rwan, Nell Patterson.

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Practical-III**	**PCH354**

A. Biochemistry

1. Qualitative and Quantitative Analysis of –

a) Carbohydrates

b) Amino acids and proteins

c) Free and bound phosphate

d) Vitamin C

B. Environmental Chemistry

1. Estimation of following in water
   (a) Ca (b) Fe (c) Mg
   (d) Chemical oxygen demand (COD)
   (e) Biochemical oxygen demand (BOD) &
   (f) Dissolved oxygen (DO)
2. Analysis of soil for the followings
   (a) Ca (b) Mg (c) Total nitrogen
   (d) Carbonate (e) Organic matter (f) Ammonia & (g) Nitrate nitrogen

Books Suggested:

1. A Textbook of Practical Biochemistry, Joshi A. Rashmi, B. Jain Publishers, 2002
2. Applications of Environmental Chemistry: A Practical Guide for Environmental Professionals, Eugene. R. Weiner.

RKDF UNIVERSITY RANCHI

MASTER OF SCIENCE (M.Sc.)
APPLIED CHEMISTRY

SEMESTER IV

Course	Subject Title	Subject Code
M.Sc. Chemistry	Organic Chemistry-III: Medicinal Chemistry	PCH401A

Unit 1

Basic Consideration of Drugs:

Classification, nomenclature and metabolism. Development of drugs: Sources, Genesis of Drugs molecular modification general and special processes: prodrugs (prolongation of action, shortening of action, drug localisation, transport regulation, adjunct to pharmaceutical formulation).

Theoretical aspects of drug action: Structure-activity, Physico-chemical parameters and pharmacological activity; drug receptors; mechanism of drug action.

Unit 2

Drugs Affecting the Central Nervous System:

Sedatives and Hypnotics- Barbiturates (structure-activity-relationship and metabolism); benzodiazepines (structure-activity-relationship and metabolism); miscellaneous compounds. Synthesis of Phenobarbital, hexobarbital nitrazepam and oxazepam.

Unit 3

Anesthetics & Analgesics:

General anesthetics; local anesthetics- Mode of action, structure-activity relationships. Synthesis of methohexital and chloro-procaine.

Synthetic analgesics, structure-activity relationships, Antipyretic analgesics, Anti-inflammatory analgesics, metabolism and mode of action. Opioid analgesics and antagonists.

Unit 4

Cardiovascular Drugs:

Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function central intervention of cardiovascular output, direct acting arteriolar dilators, Synthesis of Amylnitrate, Sorbitrate, Quinidine, Verapamil, Methyldopa, Atenolol, Oxyprenolol.

Unit 5

Local Anti-Infective Drugs:

Introduction and general mode of actions Furazolidone, Nalidixic acid, Ciprofloxacin, Norfloxacin, Dapsone, Aminosalicylicacid, Isoniazid, Ethambutol, Ethionamide, Fluconazole, Econazole.

Sulpha Drugs: Classification, structure-activity-relationship, Mode of action. Synthesis: Sulphadiazine, Sulpha isoxazole, Sulphadimethoxine.

Books Suggested:

1. Robert F.dorge Wilson and Gisvod. Textbook of organic Medicinal and Pharmaceutical Chemistry.
2. Ed. M.E. Wolff, John wiley. Berger's Medicinal Chemistry and drug discovery, Vol-I.
3. J.Faprhop and G.Penzillin. Organic synthesis-concept, method and starting material.
4. Eds.Korolkovas and Burkhattar J.H. John Wiley & sons. Essentials of medicinal Chemistry.
5. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
6. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry.

OR

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Inorganic Chemistry-III: Analytical Chemistry**	**PCH401B**

Unit 1

Statistical tests and Error Analysis:

Accuracy, precision, classification of errors, significant figures and computation, mean deviation and standard
deviation, Least square methods, regression coefficient, F-test, t-test and Chi-test.
Sampling and Sample Treatment: Factors involved in effective sampling, good samples; Representative and homogeneous, samples of mixtures.

Unit 2

Spectrochemical Analysis:

Spectrophotometry: Quantities principles of absorption, instrumentation, single beam, double beam, determination of pKa value of an indicator, detectors, applications.
Atomic spectroscopy: Principles of emissions, atomic emission spectroscopy and flame emission.

Unit 3

Electroanalytical Methods:

Theory of electro gravimetric analysis, electrode reactions, over potential, Cyclic voltammetry, Linear-scan voltammetry, Pulse voltametric methods, stripping methods.
Coulometry: Coulometric titrations and controlled- potential electrolysis.

Unit 4

Chromatography Techniques:

Classification of chromatographic separations. Theory of chromatography. Applications of chromatographic methods: Adsorption and partition chromatography. Ion exchange chromatography, LC, HPLC and GC, Column matrices, Detectors. Affinity and chiral columns (all type of chromatography).

Unit 5

Separation Techniques:

Principles of analytical separations, liquid –liquid extraction: Distribution coefficient, distribution ratio, solvent extraction of metals, analytical separations, multiple batch extractions, counter current distribution, multiple extractions.

Thermal Methods: Thermal methods of analysis: Principles and instrumentation of TG and DTA. Complementary nature of TG and DTA. Differential scanning calorimeter (DSC). Applications of thermal methods in analytical chemistry.

Books Suggested:

1. Gary D.Christian, Analytical Chemistry, John-Wiley
2. H.A.Willard, L.L.Merrit, and J.A.Dean, Instrumental Methods of Analysis, VanNostrand, New York, 1986.
3. D.A.Skoog & D.M.West Principles of Instrumental Analysis. Holt Rinahart Winston, New York, 1988.
4. K A Robinsons Chemical Analysis, Harper Collins Publishers, NewYork.
5. A.J. Bard and L. R. Faulkner, Electrochemical Methods: Fundamentals and Applications, John Wiley & Sons: New York.

OR

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Physical Chemistry-III: Spectroscopy and Diffraction**	**PCH401C**

Unit 1

Electronic Spectroscopy- Atomic Spectroscopy:

Energies of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogen atom and alkali metal atoms.

Unit 2

Electronic Spectroscopy-Molecular Spectroscopy:

Energy levels, molecular orbitals, vibronic transitions, vibrational progressions and geometry of the excited states, Franck-Condon principle, electronic spectra of polyatomic molecules. Emission spectra; radiative and non-radiative decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra.

Unit 3

X-Ray Diffraction:

Bragg condition, -Miller indices, Laue method, Bragg method, Debye-Scherrer method of X-ray structural analysis of crystals, index reflections, identification of unit cells from systematic absences in diffraction pattern. Structure of simple lattices and X-ray intensities, structure factor and its relation to intensity and electron density, phase problem. Description

of the procedure for an X-ray structure analysis, absolute configuration of molecules, Ramachandran diagram.

Unit 4

Mössbauer Spectroscopy:

Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of bonding and structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin, Sn^{+2} and Sn^{+4} compounds - nature of M-L bond, coordination number, structure and detection of oxidation state and inequivalent MB atoms.

Unit 5

Electron Spin Resonance Spectroscopy:

Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensors, application to transition metal complexes (having one unpaired electron) including biological systems and to inorganic free radicals such as PH_4, F_2^- and $[BH_3]^-$.

Books Suggested:

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Applied Electron Spectroscopy lor Chemical Analysis Ed. H. Windawi and F.L. Ho. Wiley Interscience.
3. NMR, NOR, EPR and Massbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.
4. Physical Methods in Chemistry, R.S. Drago, Saunders College.
5. Introduction to Molecular Spectroseopy, Q.M. Barrow, McCraw Hill. Introduction to Photoelectron Spectroscopy, P. K. Ghosh, John Wiley.
6. Introduction to Magnetic Resonance, A. Carrington and A.D. Maclachalan, Harper & Row.

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Organic Chemistry-IV: Chemistry of Natural Products**	**PCH402A**

Unit 1

Terpenoids:

Structure determination, stereochemistry, biosynthesis and synthesis of some common terpenoids Citral, α- Terpineol, Farnesol, Zingiberene, Santonin, Phytol and Abietic acid.

Unit 2

Alkaloids:

Structure, stereochemistry, synthesis and biosynthesis of some common alkaloids Ephedrine, Nicotine, Atropine, (+) Conin, Quinine and Morphine.

Unit 3

Steroids:

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry, Isolation, Structure determination and synthesis of: Cholesterol, Bile acids.

Hormones: Androsterone, Testosterone, Ostrone, Progesterone, Aldosterone, Biosynthesis of Steroids.

Prostaglandins: Occurrence, nomenclature, classification, biogenesis and physiological effects. Synthesis of PGE2 and PGF2a.

Unit 5

Plant Pigments:

Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Apigenin, Luteolin Quercetin, Myricetin, Vitexin, Daidzein, Aureusin, Cyanidin, Hirsutidin,

Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway.

Porphyrins: Structure and synthesis of Haemoglobin and Chlorophyll.

Pyrethroids and Rotenone: Synthesis and reactions of Pyrethroids and Rotenones. (For structure elucidation, emphasis is to be placed on the use of spectral parameters wherever possible).

Book Suggested:

1. Organic Chemistry: Vol. 1 and 2, I. L. Finar, ELBS
2. Organic Chemistry of Natural Products Vol. I and Vol. II, Gurdeep R. Chatwal,Himalaya Publishing House
3. Stereoselective Synthesis: A Practical Approach, M. Norgradi, VCH.
4. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
5. Introduction to Flavonoids, B.A. Bohm. Harwood Academic Publishers.
6. New Trends in Natural Product chemistry, Ataaur Rahman and M.L. Choudhary, Harwood Academic Publishers.

OR

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Inorganic Chemistry-IV: Photoinorganic Chemistry**	**PCH402B**

Unit 1

Photochemical Reactions:

Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, Energy dissipation by radiative and on radiative processes, absorption spectra, Franck-Condon principle, photochemical stages - primary and secondary processes.

Unit 2

Properties of Excited States:

Structure, dipole moment, acid-base strengths, reactivity, Photochemical kinetics. Bimolecular deactivation - quenching

Unit 3

Excited States of Metal Complexes:

Excited states of metal complexes: comparison with organic compounds, electronically excited states of metal complexes, charge-transfer spectra, charge transfer excitations, methods for obtaining charge-transfer spectra.

Unit 4

Ligand Field Photochemistry:

Photo substitution, photooxidation and photoreduction, lability and selectivity, zero vibrational levels of ground state and excited state, energy content of excited state, zero zero spectroscopic energy and development of the equations for redox potentials of the excited states.

Unit 5

Redox Reactions by Excited Metal Complexes:

Energy transfer under conditions of weak interaction and strong interaction-exciplex formation; conditions of the excited states to be useful as redox reactants, excited electron transfer, metal complexes as attractive candidates (2,2'-bipyridine and 1,10-phenonthroline complexes), illustration of reducing and oxidising character of Ruthenium2+ (bipyridyl complex, comparison with Fe(bipy)3; role of spin-orbit coupling-life time of these complexes. Application of redox processes of electronically excited states for catalytic purposes, transformation of low energy reactants into high energy products, chemical energy into light.

Books Suggested:

1. Concepts of Inorganic Photochemistry, A.W. Adamson and P.D. Fleischauer, Wiley.
2. Inorganic Photochemistry, J. Chem. Educ., vol. 60, no. 10, 1983.
3. Progress in Inorganic Chemistry, vol. 30, ed. S.J. Lippard, Wiley.
4. Coordination Chem. Revs., 1981, vol. 39, 121, 131; 1960, 15, 321; 1990, 97, 313.
5. Photochemistry of Coordination Compounds, V. Balzari and V. Carassiti, Academic Press.
6. Elements of Inorganic Photochemistry, G. J. Ferraudi, Wiley.

OR

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Physical Chemistry-IV: Superconductors, Solids and Liquid Crystal**	**PCH402C**

Unit 1

Super Conductivity:

Super conductivity Meissner effect, microscopic theory of superconductivity, conventional organic and high temp, superconductors, fullerenes, applications of superconductors. Transformation in crystals - thermodynamics of transformation, order-disorder transitions, martensitic transition, polymorphic transformation

Unit 2

Specific Heat of Solids:

Specific heat of solids classical theory, quantum theory of specific heats-Einstein and Debye theories, characteristic temp and its calculation, T-law. Solid state reactions, laws governing nucleation, homogeneous and heterogenous nucleation, thermodynamic barrier.

Unit 3

Polymer Liquid Crystal:

Polymer liquid crystal nematic, cholesteric and smectic phases, liquid crystalline order of the main chain and of the side groups in polymers, synthesis and properties of polymer liquid crystals, liquid crystalline order in biological materials.

Unit 4

Surface Chemistry:

Surface chemistry surface films, BET isotherm for, multilayers & its derivation, kinetics of surface processes, unimolecular and bimolecular surface reactions, electrocapillarity, electrokinetic effects, statistical mechanics of adsorption, Colloids.

Unit 5

Kinetics of Condensed Phase Reactions:

Rate determining steps in diffusion-controlled reactions and activation controlled reactions, Stokes-Einstein equation and dependence of rate constant on co-efficient of viscosity of medium, Kinetics of ionic reactions in solution-electrostatic contribution to free energy in single and double spherical models of activated complex, entropy of activation for ion-ion reactions; Kinetics of dipole-dipole reaction, ion-dipole reaction, dependence of rate constant on ionic strength and dielectric constant of medium, Bronsted-Bjerrum equation.

Books Suggested:

1. Solid State chernistry-Garner (Butterworth; London)
2. Solid State Chemistry -D.K.Chakraborty (New Age int Publication)
3. Solid State Chemistry- N. BHannay (Prentice Hall, New Jersay)
4. Physical Chemistry- Waller J. Moore
5. Principles of polymer chemistry Cornell , P. J. Flory (Univ. Press)
6. Handbook of Conducting Polymers Vol I & II" T A. Skolhia

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Practical-IV**	**PCH453**

A. Inorganic Chemistry
B. Organic Chemistry
C. Physical Chemistry

Note: **Application based practical either on A/B/C depending on the specialization taken.**

Course	Subject Title	Subject Code
M.Sc. Chemistry	**Dissertation**	**PCH464**

Dissertation/ Project Work:

The project work will consist of

(a) Field work/Lab work related to the project.
(b) Preparation of dissertation based on the work undertaken.
(c) Presentation of project work in the seminar on the assigned topic
(d) Open viva voce.