SYLLABUS

For the
M.Sc. – Chemistry
(A Four Semester Course)
Based on
Choice Based Credit System (CBCS)
M.Sc. (Chemistry)
Course Structure (CBCS Pattern)
Department of Chemistry
NGB Vishwavidyalaya
Allahabad-221505

M.Sc. (Semester I and Semester II)
(Effective from 2017 onwards)

<table>
<thead>
<tr>
<th>Paper</th>
<th>Code</th>
<th>Type</th>
<th>Title</th>
<th>Credit</th>
<th>Marks</th>
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<tbody>
<tr>
<td>Paper I</td>
<td>MCH-401</td>
<td>Core 1</td>
<td>Inorganic Chemistry I</td>
<td>3</td>
<td>100 [80+20*]</td>
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<tr>
<td>Paper II</td>
<td>MCH-402</td>
<td>Core 2</td>
<td>Organic Chemistry I</td>
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<td>Paper III</td>
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<td>Physical Chemistry I</td>
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<td>Inorganic Chemistry</td>
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Total 18 500

* Sessional Exam
** Experimental = 30; Laboratory Record = 10; Viva-voce = 10
The experimental part shall contain any two exercise from the given list.
Semester II

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<tr>
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<td>Core 5</td>
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<td>Core 6</td>
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<td>Core 7</td>
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<td>MCH-408</td>
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<td>Introduction to Analytical Chemistry</td>
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<td>Physical Chemistry Laboratory</td>
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<td>Analytical and Computational Chemistry Laboratory</td>
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M.Sc. (Semester III and Semester VI)
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<td>MCH-508</td>
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<td>Organic Photochemistry and Pericyclic Reactions</td>
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<td>Extraction and Chromatography</td>
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<td>MCH-5L4</td>
<td>Lab 8</td>
<td>Project/Dissertation/Seminar</td>
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List of elective Papers:

1. Catalysis and Green Chemistry
3. Electrochemistry.
4. Organometallic Chemistry of Transition Metals
5. Bioinorganic Chemistry.
7. Nanochemistry.
8. Cheminformatics.
Syllabus

M.Sc (Chemistry)

Semester I

Inorganic Chemistry I (MCH-401)

Unit I

Review of Bohr’s theory, its limitations and atomic spectrum of hydrogen atom.


Unit II

Bonding and structure: Types of bonds, orbital symmetry and overlaps, concept of MO and VB theory, concept of hybridization, bond energy and covalent radii, concept of resonance, molecular dipole moment; polarizing power and polarizability, Fajan’s rules.

Unit III

Inorganic Spectroscopy I: Number of microstates and term symbols for gaseous free atoms and ions. Spin-orbit coupling in free ion terms. Hund’s rules. Splitting of spectroscopic terms of \( p^2 \) and \( d^2 \) configurations.

Unit IV


Unit V

Introduction to transition metal complexes: Brief review of the general characteristics of transition elements, types of ligands, nomenclature of coordination complexes, chelates, chelate effect, geometry and isomerism, formation of complexes, stability constants, Werner, Sidwick and VSEPR theory.
Books Suggested (Names of Publishers may vary as per copyright status):


Organic Chemistry I (MCH-402)

Unit I

Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.

Unit II

Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.

Unit III

Organic reactive intermediates; Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.

Unit IV

Aliphatic Nucleophilic Substitution:
The $S_N2$, $S_N1$, mixed $S_N1$ and $S_N2$ and SET mechanisms.
The neighboring group mechanism, neighboring group participation by p and s bonds, anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, norbornyl system, common carbocation rearrangement. The $S_N1$ mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis, ambident nucleophile and regioselectivity.

Unit V

Aliphatic Electrophilic Substitution
Bimolecular mechanisms, - $S_E2$ and $S_E1$. The $S_E1$ mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.
Books Suggested (Names of Publishers may vary as per copyright status):


Physical Chemistry I (MCH-403)

Unit I


Unit II

Thermodynamics:

Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar free energy, partial molar volume and partial molar heat content and their significance. Determinations of these quantities. Concept of fugacity and determination of fugacity.

Unit III


Unit IV

Adsorption:

Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), Surface films on liquids (Electro-kinetic phenomenon).

Unit V

Micelles:

Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass action models, solublization, micro emulsion, reverse micelles.

Books Suggested (Names of Publishers may vary as per copyright status):

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Physical Chemistry, Levine
3. Fundamental of Molecular Spectroscopy, C.N. Banwell.
4. Thermodynamics, Gurdeep Raj

Quantum Chemistry(MCH-404)

Unit I


Unit II
Concept of operators in quantum mechanics - operators for velocity, kinetic energy, momentum and angular momentum. Laplacian and Hamiltonian operator, Schrödinger’s equation and its solution for Hydrogen atoms. Derivation of Heisenberg’s uncertainty principle.

**Unit III**

Quantum mechanical approaches to molecular Bonding, Born-Oppenheimer approximation. Valence bond theory and molecular orbital theories. Valence bond theory and its application to homonuclear (Hydrogen) and heteronuclear (HCl) diatomics.

**Unit IV**


**Unit V**


**Books Suggested** (Names of Publishers may vary as per copyright status):


**Inorganic Chemistry Laboratory (MCH-4L1)**

1. Qualitative analysis of inorganic mixture for seven radicals only (including interfering radicals, insolubles, and two rare elements).

2. Quantitative separation and estimation of individual metal component from binary mixture solution (either both component gravimetrically or one component gravimetrically and other one volumetrically).

**Organic Chemistry Laboratory (MCH-4L2)**

Organic synthesis: Any two from

Acylation: Acetylation of cholesterol and separation of cholesteryl acetate by column chromatography.
Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol.

Aldol condensation: Dibenzalacetone from benzaldehyde.

Sandmeyer reaction: p-Chlorotoluene from p-toluidine.

Cannizzaro reaction: p-Chlorobenzaldehyde as substrate.

Friedel Crafts reaction: Benzoyl propionic acid from succinic anhydride and benzene.

Aromatic electrophilic substitutions: Synthesis of p-bromoaniline.

Semester II

Inorganic Chemistry II (MCH-405)

Unit I

Theories of the co-ordinate linkage: Valence bond, crystal field, ligand field and molecular orbital theories. Crystal field splittings of d-orbitals in octahedral, trigonal bipyramidal, square pyramidal, tetragonal and square planar fields. Crystal field stabilization energy (CFSE). M.O. energy level diagram for octahedral and tetrahedral complexes (with s bonding only). Spectrochemical series.

Unit II

Electronic absorption spectra of transition metal complexes. Orgel diagrams for d^1, d^4, d^6 and d^9 configurations with D ground state. Jahn-Teller effect. Stabilization of less familiar oxidation states of transition metals via coordination.

Unit III


Unit IV

Chemistry of f-Block Elements: Comparative study of lanthanides and actinides with special reference to electronic structure. Oxidation state, coordination number, structure, stereochemistry and magnetic and spectral properties.

Unit V


Books Suggested (Names of Publishers may vary as per copyright status):

Organic Chemistry II (MCH-406)

Unit I

Aromatic Electrophilic Substitution:

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack. Diazonium coupling Vilsmeier reaction, Gatterman-Koch reaction.

Unit II

Aromatic Nucleophilic Substitution:

The $S_{N}Ar$, $S_{N}1$benzyne and $S_{RN}1$ mechanisms. Reactivity-effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser and Smiles rearrangements.

Unit III

Free Radical Reactions:

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighboring group assistance, reactivity for aliphatic and aromatic substrates at a bridgehead, Reactivity in the attacking radicals. The effect of solvent on reactivity. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto oxidation, coupling of alkynes and arylation on aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

Unit IV

Addition to Carbon-Hetero Multiple Bonds:

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds, Witting reaction.


Unit V

Elimination Reactions:
The E₂, E₁ and E₁cB mechanisms, orientation of the double bond. Reactivity-effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

**Books Suggested** (Names of Publishers may vary as per copyright status):


**Physical Chemistry II (MCH-407)**

**Unit I**

Chemical Kinetics:

Basic Chemical Kinetics, molecularity, order and rate of reactions, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, treatment of unimolecular reactions.

**Unit II**

Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogenbromine and hydrogen-chlorine reactions) and homogenous catalysis, kinetics of enzyme reactions, general features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis ad the nuclear magnetic resonance method.

**Unit III**

Dynamics of unimolecular reactions (Lindemann Hinshelwood and Rice-Ramsperger-Kassel-Marcus (RRKM) theories for unimolecular reactions).

**Unit IV**

Chemistry of Macromolecules:


**Unit V**
Non Equilibrium Thermodynamics:

Thermodynamic criteria for non-equilibrium states, entropy production and entropy flow, entropy balance equations for different irreversible processes (e.g., heat flow, chemical reaction etc.) transformations of the generalized fluxes and forces, non equilibrium stationary states, phenomenological equations, microscopic reversibility and Onsager’s reciprocity relations, electrokinetic phenomena, diffusion, electric conduction.

Books Suggested (Names of Publishers may vary as per copyright status):

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Physical Chemistry, Levine
3. Thermodynamics, Gurdeep Raj
8. Polymer Chemistry, B. K. Sharma.

Introduction to Analytical Chemistry (MCH-408)

Unit I

Errors analysis: Accuracy and precision, absolute, relative, determinate and indeterminate errors, statistical treatment of random errors, computation rules for significant figures, method of least squares, mean deviations, and standard deviation.

Unit II

Tests of significance, the ‘t’ test, the ‘F’ test, the \( \chi^2 \) (chi-squares) test, distribution normalcy test. Regression analysis; methods of least squares the correlation coefficient, Rejection of observations; the ‘Q’ test.

Unit III

Titrations: Acid-base, complexometric, conductometric and potentiometric titration- theory of acid base indicators, Mohr, Volhard and Fajan’s methods, EDTA based titration, Redox indicators, and their use in volumetric analysis.

Unit IV

Methodology and instrumentation of spectrophotometry in visible, ultraviolet and infra-red regions, spectrometric error, deviation from Beer’s law, analysis of mixtures.

Unit V

Separation Techniques: Solvent extraction, thin-layer chromatography, gas chromatography (GC), liquid chromatography (LC), high performance liquid chromatography (HPLC), ion exchange chromatography, gel permeation chromatography. Chromatography coupled instrumentation.

Books Suggested (Names of Publishers may vary as per copyright status):

4. Principles of Instrumental Analysis, D.A. Skoog, W.B. Saunders.

Physical Chemistry Laboratory (MCH-4L3) (Any two exercise):

(i) Determination of the velocity constant of the reaction between acetone and iodine catalysed by HCl/H2SO4.
(ii) Determination of velocity constant of saponification of ethyl acetate with sodium hydroxide.
(iii) Kinetics of reaction between copper sulphate and sugars in alkaline medium.
(iv) Titration of acid versus base using pH meter and calculation of pKa value of an acid.
(v) Elevation of boiling point using Landberger’s apparatus.
(vi) To study the adsorption of oxalic acid on activated charcoal and test the validity of Freundilich’s adsorption isotherm.
(vii) Rast method for determining molar mass.

Analytical and Computational Chemistry Laboratory (MCH-4L4) (Any two exercise):

1. Separation techniques: Ion-exchange and solvent extraction.
4. Electrometric techniques: pH, Conductometry, Potentiometry (Ag, Sb, Pt electrodes).
5. Role of computer software and program in solving chemistry problems
6. Introduction to different structure, object drawing & solving software’s, structural elucidation and reaction pathway prediction using analytical tools, different mathematical and analytical tools (Gaussian, MATLAB and Mathematica) will be introduced.

**Semester III**

**Group theory and Molecular Spectroscopy (MCH-501)**

**Unit I**

Group Theory: Introduction, Molecular symmetry and point groups, symmetry elements and operators, classes of symmetry operation, symmetry classification of molecules. Matrix representation of symmetry operations, representation of groups, character, reducible and irreducible representations, great orthogonality theorem, character tables, symmetry properties of Hamiltonian operator, mutual exclusion principle.

**Unit II**


**Unit III**

Raman Effect: classical and quantum theory of Raman effect, rotational and vibrational Raman spectra. Franck-Condon principle, transition moments, assignment of electronic transitions of N₂, H₂O and formaldehyde using group theory.

**Unit IV**

Introduction to NMR: Origin of magnetic moments in matter, electronic and nuclear moments, interaction with magnetic field, Larmor equation - conditions for magnetic resonance absorption, relaxation times, line widths and line shapes, ring currents, diamagnetic anisotropy, spin-spin splitting, high resolution NMR spectra of simple molecules.

**Unit V**

Books Suggested (Names of Publishers may vary as per copyright status):


Statistical Thermodynamics (MCH-502)

Unit I

Unit II

Unit III
Third Law of thermodynamics (i) Nernst heat theorem, (ii) Entropy of chemical reactions (iii) statements of third law of thermodynamics and (iv) Conventional entropies.

Unit IV
Expression for equilibrium constant in terms of partition functions. Equilibrium constants of simple systems - (i) Ionization of metal atoms, (ii) Dissociation of diatomic molecules and (iii) Isotopic exchange equilibria. Calculation of thermodynamic properties from spectroscopic data.

Unit V

Books Suggested (Names of Publishers may vary as per copyright status):

2. Statistical Mechanics, D.A. Mcquarrie, California University Science Books
Spectroscopic Identification of Organic Compounds (MCH-503)

Unit I


Unit II

Nuclear Magnetic Resonance Spectroscopy:

Basic principles. Introduction to NMR techniques. CW and FT NMR techniques. $^1$H NMR Spectral parameters – intensity, chemical shift, multiplicity, coupling constant. Analysis of first order and second - order spectra. Structure determination of organic compounds by $^1$H NMR spectra.

Unit III

Carbon-13 NMR Spectroscopy:

General considerations, chemical shift (aliphatic olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Two dimension NMR spectroscopy-COSY, NOESY, DEPT, HMBC and HMQC techniques.

Unit IV


Unit V

Solution of Structural problems by joint application of UV, IR, NMR $^1$H and $^{13}$C) and mass spectroscopy.
Books Suggested (Names of Publishers may vary as per copyright status):

2. Elementary Organic Spectroscopy, Y R Sharma, S Chand.

Organic Reactions Mechanisms (MCH-504)

Unit I

Molecular Rearrangements I:


Unit II

Molecular Rearrangements II:

1. Migration to electron deficient nitrogen atom - Wolf, Hofmann, Curtius, Losen, Schmidt, Beckmann rearrangement.
2. Migration to electron deficient oxygen atom - Baeyer-Villiger rearrangement.

Unit III

Oxidation:


Unit IV

Reduction:

Unit V

Organometallic Reagents:

Principle, preparations, properties and applications of the following in organic synthesis with mechanistic details. Group I and II metal organic compounds: Li, Mg, Hg, Cd, Zn and Ce Compounds.

Books Suggested (Names of Publishers may vary as per copyright status):


Synthetic Chemistry Laboratory (MCH-5L1) (Any two exercise):

[A] Multi-step synthesis of Organic Compounds: (any two from the list given below)

The exercises should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques.

Photochemical reaction: Benzophenone → Benzpinacol → Benzpinacolone
Beckmann rearrangement: Benzanilide from benzene, Benzene → Benzophenone → Benzphenone oxime → Benzanilide.

Benzilic acid rearrangement: Benzilic acid from benzoin, Benzoin → Benzil → Benzilic acid

Synthesis of heterocyclic compounds:

Skraup synthesis: Preparation of quinoline from aniline.
Fischer-Indole synthesis: Preparation of 2-phenylindole from phenylhydrazine

Enzymatic synthesis:

Enzymatic reduction: Reduction of ethylacetoacetate using Baker’s yeast to yield enantiomeric excess of S (+) ethyl-3-hydroxybutanoate and determine its optical purity.

Biosynthesis of ethanol from sucrose.

Synthesis using microwaves: Alkylation of diethyl malonate with benzyl chloride.

Synthesis using phase transfer catalyst: Alkylation of diethyl malonate or ethyl acetoacetate with an alkyl halide.

[B] Preparations (Complex compounds); (any two from the list given below):
(a) Ferric alum (ferric ammonium sulphate)
(b) Tetraammine copper (II) sulphate
(c) Potassium trioxalatocromate (III)/aluminate (III)/ferrate (III)
(d) Silver/copper tetraiodomercurate (II)
(e) Sodium hexanitritocobaltate (III)
(f) Prussian blue
(g) Ammonium diamminetetrithiocyanato-chromate (III)
(h) Pentamminechloro-nitritocobalt (III) chloride
(i) Hexaureachromium (III) chloride trihydrate

**Spectroscopic Methods (MCH-5L2)** (Any two exercise):

1. Identification of organic compound by the analysis of their spectral data (UV, IR, PMR, CMR and MS).
2. Spectrophotometric (UV/VIS) Estimations:
3. Colorimetric determination of copper, iron and phosphate.
Semester IV

**Elective 1 (MCH-505):** Choose from the list of elective papers.

**Elective 2 (MCH-506):** Choose from the list of elective papers.

**Elective 3 (MCH-507):** Choose from the list of elective papers.

**Organic Photochemistry and Pericyclic Reactions (MCH-508)**

**Unit I**

Organic Photochemistry I:

Photochemistry of Carbonyl Compounds: Photochemistry of enones, hydrogen abstraction, rearrangements of α, β unsaturated ketones and cyclohexadienones, photochemistry of p-benzoquinones.

**Unit II**

Organic Photochemistry II

Photochemistry of unsaturated system: Olefins, cis-trans isomerization, dimerization, hydrogen abstraction and additions. Acetylenes-dimerization, Dienes-photochemistry of 1, 3-butadiene,(2+2) additions leading to cage structures, photochemistry of cyclohexadienes.

**Unit III**

Organic Photochemistry III

Photochemistry of aromatic compounds-exited state of benzene and its 1, 2 and 1, 3-shifts, Photo-Fries rearrangement, Photo-Fries reaction of anilides, photosubstitution reaction of benzene derivatives. Photolysis of nitride esters and Barton reaction.
Unit IV

Pericyclic Reactions:

Molecular orbital symmetry, Frontier orbitals of ethylene, 1, 3-butadiene, 1, 3, 5-hexatriene and allyl system. Classification of pericyclic reactions, Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions-conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadditions-antrafacial and suprafacial additions. 4n and 4n+2 systems, 2+2 addition of ketenes, 1, 3 dipolor cycloadditions and cheleotropic reactions.

Unit V

Sigmatropic rearrangements:

Suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, retention and inversion of configuration, (3,3) and (5,5) sigmatropic rearrangements. detailed treatment of Claisen, Cope and aza-Cope rearrangements. Fluxional tautomerism. Ene reaction.

Books Suggested (Names of Publishers may vary as per copyright status):

1. Photochemistry and Pericyclic Reactions, Jagdamba Singh, Jaya Singh, New Age International

Extraction and Chromatography (MCL- 5L.3) (Any two exercise):

[A] Extraction of Organic Compounds from Natural Sources:

1. Isolation of caffeine from tea leaves. 2. Isolation of nicotine dipicirate from tobacco.
3. Isolation of lycopene from tomatoes. 4. Isolation of b-carotene from carrots.
5. Isolation of eugenol from cloves. 6. Isolation of (+) limonine from citrus rinds.

[B] Separation of following cations by Paper Chromatography:

(i) Ag(I), Pb(II) and Hg(II)
(ii) Hg(II), Cu(II) and Pb(II)
(iii) Ni(II), Co(II) and Zn(II)
(iv) Ni(II), Co(II) and Cu(II)

[C] Separation and identification of the components present in the given organic mixture by chromatographic methods.

**Project/Dissertation/Seminar (MCH-5L4)**

Individual faculty members will float stipulated number of projects. Students have to consult respective faculty members and select projects. More than one student can work under a single project based on nature of the project. Guide allotment for MSc project will be based on choice cum merit.

Once guide allotment (either single or more than one guide) is declared, student has to submit research proposal and give a presentation, either individually or one member from the group. Research proposal and presentation carries 20 marks. Students will be periodically assessed for their project work by individual faculty member or group of faculty members. The final submission of the research project, i.e., small thesis, presentation and comprehensive viva carries 40 marks.

Note:

1. Student should submit 3 copies of the final research project copy in hard binding format with all declarations and signatures.
2. For referencing any ACS journal pattern should be followed.

**Seminar:**

Student should approach faculty members for seminar presentation on recent literature on particular topic. The remaining 20 marks will be credited for this assessment.

**Elective Papers (MCH-50X)**

Electives will be covered according to availability of expert faculty members in the Department. Students will be given choice to select and as per majority students choice elective will be
conducted. In total, students have to take three discipline specific electives for completing M.Sc. Course.

1. **Catalysis and Green Chemistry**

   **Unit I**

   Basic Principles of Green Chemistry: Prevention of waste by products, maximum incorporation of the reactants into the final product, prevention or minimization of hazardous products, designing safer chemicals, energy requirements for synthesis, selection of appropriate solvent, selection of starting materials, use of protecting groups.

   **Unit II**

   Green Reagent: Dimethylcarbonate, polymer supported reagent, polymer supported peracids, Poly-N-bromosuccinimide (PNBS), sulfonazide polymer, polystyrene Wittig reagent and polymer supported peptide coupling agent, miscellaneous reagents.

   **Unit III**

   Introduction and Basic concept of green catalysis, Application of catalyst functionality, concepts for control of reaction, selectivity and kinetic models. Steps in catalytic reaction (Adsorption and Kinetic models). Selection and design and Preparation of catalysts.

   **Unit IV**

   Green Catalyst: Acid catalyst, oxidation catalyst, basic catalyst, polymer supported catalyst, polystyrene – aluminium chloride, polymer supported photosensitizers, miscellaneous illustration and solid support reagents.

   **Unit V**


**Books Suggested** (Names of Publishers may vary as per copyright status):

2. Introduction to Green Chemistry, V.Kumar.

2. **Concepts in Organic Synthesis**

**Unit I**

Disconnection Approach: General introduction to synthons and Synthetic equivalents, Disconnections, (C-C, C-S, C-O, bonds), Functional group interconversion, chemoselectivity, cyclisation reaction, choosing synthetic route for small and large scale synthesis.

**Unit II**

Synthetic Strategies: (a) For formation of carbon-carbon bond (b) For formation of carbon-nitrogen bond (c) Formation of carbon-halogen bond (d) Ring Synthesis and (e) Multistep Synthesis.

**Unit III**

(i) Protecting Groups: Principle of protection of alcoholic, amino, carbonyl and carboxylic groups.

**Unit IV**

Reagents in Organic Synthesis:
(i) Complex metal hydrides. (ii) Gilman’s reagent. (iii) Lithium disopropyl amide (LDA).

**Unit V**


Nitrogen, Sulphur and Phosphorus Ylides: Preparation and their synthetic applications.

**Books Suggested** (Names of Publishers may vary as per copyright status):
3. **Electrochemistry**

**Unit I**

Equilibrium electrochemistry: Activities in electrolytic solutions, mean activity coefficient, Debye-Huckel treatment of dilute electrolyte solutions, origin of electrode potential, half-cellpotential, electrochemical cell, Nernst equation, thermodynamics of electrochemical cell.

**Unit II**

Dynamic electrochemistry: Electrical double layer - electrode kinetics, rate of charge transfer, current density, Butler- Volmer equation,

**Unit III**

Introduction to polarography, cyclic voltammetry, theory of corrosion and inhibition of corrosion.

**Unit IV**

Bioelectrochemistry: bioelectrodics, membrane potentials, simplistic theory, modern theory, electrical conductance in biological organism: electronic, protons electrochemical mechanism of nervous systems, enzymes as electrodes.

**Unit V**

Electrochemical sensors: Potentiometric sensors, Ion-selective electrodes, Membrane electrodes, Amperometric sensors, Clark and Enzyme electrodes).

**Books Suggested** (Names of Publishers may vary as per copyright status):

4. **Organometallic Chemistry of Transition Metals**

   **Unit I**

   Inorganic π Acid Ligands: Dioxygen and dinitrogen, nitrosyl, tertiary phosphines and arsines as ligands. Complexes of σ donor ligands: Transition metal alkenyls, alkynyls, carbenes and carbindes.

   **Unit II**

   π complexes of unsaturated molecules: Preparation, bonding and structure of alkene, alkyne, allyl, dienyl and trienyl complexes; reactions with special reference to organic synthesis.

   **Unit III**

   Transition organometallic compounds:
   Transition metal compounds with bonds to hydrogen, boron, silicon

   **Unit IV**

   Transition metal compounds in catalysis: Hydrogenation, hydroformylation and polymerization; Wacker Process.

   **Unit V**


**Books Suggested** (Names of Publishers may vary as per copyright status):


5. **Bioinorganic Chemistry**
Unit I


Unit II


Unit III

Role of Metal Ions in Biological Systems: Essential and trace metal ions. Metal ions storage and transport (Na, K, Ca, Mg, Fe, Cu and Zn)-Ferritin and Transferrin. Metal ion toxicity and its cure by chelating agents. Pharmacological activity and metal chelates. Carcinogenic metals, carcinogenic and carcinostatic ligands.

Unit IV


Unit V

Electron Transport Proteins (a) Iron-Sulfur Proteins-Rubredoxin and Ferredoxins, (b) Cytochromes (types a, b and c).

Books Suggested (Names of Publishers may vary as per copyright status):


6. Bioorganic and Medicinal Chemistry

Unit I
Enzymes: Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fisher’s lock and key and Koshland’s induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition.

Unit II

Mechanism of Enzyme Action: Transition-State theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase A.

Unit III

Relationship of chemical structure and biological activities and theories of drug action. Detailed study of following classes:

Unit IV

(i) Local Anti-infective Drugs: Antitubercular drugs and Antimalerial drugs: Introduction and general mode of action. Study of sulphonamides, ciprofloxacin, norfloxacin, amino salicylic acid.
(ii) Psychoactive Drugs: CNS depressants general anaesthetics, hypnotics, sedatives, anti-anxiety drugs, benzodiazepines. Antipsychotic drugs: diazepam, alprazolam, trimethadione, barbiturates and glutethimide.
(iii) Antibiotics: Penicillin G, chloramphenicol, cephalosporin, tetracycline and streptomycin.

Unit V

Vitamins and Hormones: Detailed study of chemistry of Vit. B₁, Vit. C₁, Pantothenic acid, Biotin (Vitamin H) and α-tocopherol (Vitamin E). Biological action of vitamins. Insect hormones: Pheromones and Juvenile hormones; Plant hormones: Gibberellins.

Books Suggested (Names of Publishers may vary as per copyright status):
1. Introduction to Bioorganic Chemistry and Chemical Biology, David Van Vranken, Gregory A, Garland Science (Taylor & Francis).

7. **Nanochemistry**

   **Unit I**

   Introduction: History scope and perspectives of nanochemistry. Synthesis and Stabilization of Nanoparticles, Chemical Reduction; Reactions in Micelles, Emulsions, and Dendrimers; Photochemical and Radiation Chemical Reduction.

   **Unit II**


   **Unit III**

   Size Effects in Nanochemistry: Models of Reactions of Metal Atoms in Matrices; Properties; Kinetic Peculiarities of Chemical Processes on the surface of Nanoparticles; Thermodynamic Features of Nanoparticles.

   **Unit IV**

   Applications of Nanoparticle in various fundamental research, industries, medical field.

   **Unit V**

   Environmental issue; toxicity, biosafety and ethical issue in applications of Nanoparticle.

**Books Suggested** (Names of Publishers may vary as per copyright status):


8. **Cheminformatics**

**Unit I**

Introduction to cheminformatics, History and Evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and Structure Elucidation.

**Unit II**

Role of computers in chemical research, Introduction to Chemoinformatics, Representation and manipulation of 2D and 3D molecular structures, Chemical Databases- Design, Storage and Retrieval methods.

**Unit III**

Reaction databases, Representation of chemical reactions, Search techniques (Full, Sub and Super structure), Similarity searches, modelling of small molecules.

**Unit IV**


**Unit V**

Combinatorial chemistry and Library design –Introduction, Data visualization, Data mining methods, Prediction of ADMET properties, Chemoinformatics tools for drug discovery.

**Books Suggested** (Names of Publishers may vary as per copyright status):

1. An Introduction to Chemoinformatics, Andrew R. Leach, V.J. Gillet, Springer.

9. **Analytical Chemistry**
Unit I

Introduction to Analytical Chemistry- Methods of qualitative and quantitative analysis.

Unit II

Thermal Analysis: Introduction, types and applications of thermoanalytical methods, thermogravimetry etc.

Unit III


Unit IV

Diffraction Techniques: Introduction, types and applications with special reference to x-ray diffraction technique.

Unit V

Electrochemical Techniques: Introduction and applications of Electrolysis, Electrophoresis.

Books Suggested (Names of Publishers may vary as per copyright status):

5. Principles of Instrumental analysis, D.A. Skoog, J.L. Loary, W.B. Saunders.
6. Principles of Instrumental Analysis, D.A. Skoog, W.B. Saunders.