SCHEME OF EXAMINATION

AND

COURSE OF STUDY

CHOICEBASEDCREDITSYSTEM (CBCS)

And

LOCF

M.Sc.(CHEMISTRY)

(w.e.f. 2022-2023)

DEPARTMENT OF CHEMISTRY

GURUKUL KANGRI (DEEMED TO BE UNIVERSITY), HARIDWAR

27 May, 2022

PROGRAMME- M.Sc. Chemistry

PROGRAMME OBJECTIVES:

It is a job oriented, innovative and applied programme. The main objectives of the programme are to-

1. Provides opportunity to students as Quality Control Chemist, Research and Development Chemist, Analytical Chemist in various laboratories and institutions.
2. Develops analytical skill amongst students
3. To Acquire knowledge of modern as well as Vedic concept of chemistry
4. Equip students to step up in research and development

PROGRAMME OUTCOMES:

After studying this programme students become able to -

1. Familiar with the knowledge of theoretical aspects of Inorganic, Organic, Physical and Analytical Chemistry
2. Explain working principle, instrumentation and application of various experiments by performing more practices in the laboratories.
3. Develop skills to handle analytical techniques in industry, research and institutes.
4. Discuss modern as well as Vedic concept of chemistry
5. Employ critical thinking and scientific knowledge to design, carry out, record and analyse the results
6. Describe about environment, chemicals and pollution problems in details
7. Accomplish their goals in professional and academic life.
8. Be provided with the knowledge to step up in Research and Development.

Course Title: Chemistry Core-1: General Inorganic Chemistry *w.e.f. the session 2022-23 and onwards*	
Class: M.Sc. Pt.-I / Semester-I	**Course code: MCH-C101**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

NOTE: The question paper shall consist of Two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer (about 150 words) type questions of SIX marks each and student shall be required to attempt any five questions. Sec.-B shall contain 08 descriptive type questions of TEN marks each and student shall be required to attempt any four questions. Both sections shall have questions from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

COURSE CONTENTS:

Unit - I

COORDINATION CHEMISTRY: Distortion in Complexes**,** Molecular orbital theory (M.O.T.) as applied to octahedral complexes, π - bonding in octahedral complexes, inert and labile complexes based on various theories, ligand substitution reaction in octahedral and square planar complexes, electron transfer reaction in coordination compounds.

Unit - II

ELECTRONIC SPECTRA OF COMPLEXES: Term symbols S,P,D,F, in a cubic field; splitting of term for d configuration; spectra of Transition metal complexes, selection rules and intensities of the transitions, nature of Electronic transitions in complexes, orgel energy level diagram, tanabe-sugano diagram. Calculation of Dq, B' and β for Cr III and Ni II complexes. Structural Evidence from Electronic spectra, charge-transfer spectra.

Unit - III

MAGNETOCHEMISTRY: Contribution of magnetic properties, Effect of the ligand field on spin-orbit coupling, measurement of magnetic properties, methods of magnetic susceptibility determination, temperature dependence of magnetism, application of magnetic data (Ref. book : Drago)

MOLECULAR SYMMETRY: Symmetry elements, Symmetry operations and point groups, Character Tables(C_{2V}) and applications.

Unit - IV

BIOINORGANIC CHEMISTRY: General introduction to Bio-inorganic Chemistry; occurrence of Inorganic elements in organisms, classification of metallo bio-molecules; Biologically important features and functions of inorganic elements, Biologically important ligands for metal ions, co-ordination by proteins and Enzymatic catalysis.

Role of metal ions and non-metals in Biological systems Na, K, Ca, Mg, Zn, Cl, Si, As, F, I,Se (Giving suitable examples) Biomineralisation.

Unit - V

OXYGEN CARRIERS: Haemoglobin; non-porphyrin and porphyrin oxygen carriers, synthetic oxygen carriers. Recent trends in

Nitrogen fixation, photosynthesis PS- 1 & PS - 11, superoxide Dismutase.

Suggested Readings:

1. Inorganic Chemistry by: James E. Huheey
2. Text Book of Inorganic chemistry by: Cotton and Wilkinson 5th Edition
3. Physical Methods in Inoganic Chemistry by: R.S.Drago
4. Selected Topics in Inorganic Chemistry by: Malik, Tuli & Madan
5. Bioinorganic and Supramolecular Chemistry by: A.K.Bhagi, G.R.Chatwal

COURSE OBJECTIVES:

1. Coordination chemistry.
2. Electronic spectra of complexes
3. Knowledge of Magnetochemistry.
4. Molecular symmetry.
5. Basic concepts of Bio-inorganic chemistry
6. Oxygen Carriers

COURSE OUTCOMES:

On completion of this course, student shall be able to:
CO 1: Understand the basic concepts behind metal ligand bonding in octahedral complexes, reactions taking place in octahedral and square- planar complexes, trans effect and its applicability in synthesis of different metal complexes
CO 2:Deduce terms, state & microstate and explain L-S coupling scheme, Racah parameters, orgel diagram, tanabe-sugano diagram alongside classify the transitions on the basis of selection.

CO 3: Enlist different magnetic properties existing in chemical compounds. Student can classify & recognize the symmetry elements and their operations & be able to find point group of molecule by systemic procedure and its application in chemistry
CO 4: Able to describe how metal ions take part in biological system and their concentration effect and physiological effect on biological system and recognize organic chemical reactions embodied in biochemical processes
CO 5: Able to recognize role of porphyrin ring in hemoglobin and chlorophyll and Associate the bioinorganic chemistry with function of hemoglobin in addition to enumerate the chemical aspects of photosynthesis and nitrogen fixation.

Mapping of Course outcomes (Cos) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1	X				X			X
CO 2	X		X		X			X
CO 3	X				X			X
CO 4	X		X			X		X
CO 5	X					X		X

Course Title: Chemistry Core-2: General Organic Chemistry *w.e.f. the session 2022-23 and onwards*	
Class: M.Sc. Pt.-I / Semester-I	**Course code: MCH-C102**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

NOTE: The question paper shall consist of Two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer (about 150 words) type questions of SIX marks each and student shall be required to attempt any five questions. Sec.-B shall contain 08 descriptive type questions of TEN marks each and student shall be required to attempt any four questions. Both sections shall have questions from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

COURSE CONTENTS:

Unit - I

Organic Reaction Mechanism:

(a) Substitution or Displacement Reactions: Nucleophilic and electrophilic substitutions with mechansim (S_N and S_E), Frie's rearrangement, Friedeal-Craft reactions, Reimer-Tiemann reaction, Chichibabin reaction.

(b) Addition Reactions: Electrophilic and nucleophilic additions with mechanism, hydroboration, Michael addition, sharpless asymmetric epoxidation; aldol, Perkin, Stobbe condensations, Cannizaro reaction, Wittig reaction.

Unit - II

Reaction Intermediates: Carbocations, carbanions, free radicals, nitrines and benzyne, their formation, stability, detection and reactions.

Molecular rearrangements: Involving electron deficient carbon, nitrogen and oxygen viz- Pinacol-pinacolone, Wagner-Meerwein, Beckmann, Hofman, Lossen, Curtius, Schmidt rearrangements, Bayer-Villiger oxidation of ketones. Favorskii, Demjanov rearrangements.

Unit - III

Reagents in organic synthesis: Useof the following reagents in organic synthesis: Gilman's reagents, lithium diisopropyl amide (LDA), 1,3-dithiane, osmium tetroxide, selenium dioxide.

Heterocyclic Compounds: Aromaticity, synthetic methods and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis.

Unit - IV

Pericyclic reactions: Classification of Pericyclic reactions**,** Selection rules and stereochemistry of electrocyclic reactions, cycloaddition and sigmatropic shifts. Sommelet-Hauser, Cope and Claisen rearrangements, ene reaction.

Photochemical reactions: Cis-trans isomerization, Paterno-Buchi reaction, Norrish type I and II reactions of α, β unsaturated ketones, photoreduction of ketones, di-pimethane rearrangement, photochemistry of arenes.

Unit - V

Stereoisomerism: Optical activity and Optical isomerism, Racemic mixture, Resolution, R-S nomenclature. Geometrical isomerism in the compounds containing C = C and C = N bonds, elementary idea of geometrical isomerism in cyclic compounds. E-Z nomenclature.

Stereochemistry: Asymmetric induction, prochiral relationships, stereoselective and stereospecific reactions and their use in reaction mechanism, Stereochemistry of substituted cycloalkanes.

Suggested Readings:

1. Organic Chemistry by: Boyd and Morrison
2. Organic Chemistry by: I.L.Finar
3. Organic Chemistry by: Kapoor, Singh and Mukherjee
4. Organic Chemistry by: Bruice

5. Organic Chemistry by: Pine
6. A Guide Book to Organic Reaction Mechanism by: Peter Sykes

COURSE OBJECTIVE:

1. Organic Reaction Mechanism.
2. Reaction Intermediates.
3. Reagents in organic synthesis.
4. Heterocyclic Compounds
5. Pericyclic reactions
6. Photochemical reactions
7. Stereoisomerism
8. Stereochemistry

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Understand the different organic reactions and their mechanism.
CO 2: Familiarize the various types of substitution reaction and their mechanism.
CO 3: Learn the concept of Reaction Intermediates.
CO 4: Explain the use of important reagents in organic reaction.
CO 5: Explain the pericyclic reactions and its classification.
CO 6: Describe the photochemical reaction.
CO 7: Describe the versatile knowledge of rearrangements.

Mapping of Course outcomes (COs) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1	X				X		X	X
CO 2	X		X		X		X	X
CO 3	X						X	X
CO 4	X		X					X
CO 5	X		X				X	X
CO 6	X				X		X	
CO 7	X				X		X	X

Course Title: Chemistry Core-3: General Physical Chemistry *w.e.f. the session 2022-23 and onwards*	
Class: M.Sc. Pt.-I / Semester-I	**Course code: MCH-C103**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

NOTE: The question paper shall consist of Two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer (about 150 words) type questions of SIX marks each and student shall be required to attempt any five questions. Sec.-B shall contain 08 descriptive type questions of TEN marks each and student shall be required to attempt any four questions. Both sections shall have questions from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

COURSE CONTENTS:

Unit - I

Chemical Kinetics - I: Derivation of IIIrd order kinetic equation, collision theory for uni, bi and termolecular reactions, Steric factor, Theory of absolute reaction rates, Entropy of activation. Experimental techniques for the study of kinetics of slow and fast reactions. Potential energy surfaces (two-dimentional and 3-dimentional diagrams), P.E. surface for $H + H_2$ reaction, Concept of COL and Contour diagram.

Unit - II

Chemical Kinetics - II: Opposing, Consecutive, Side and Induced reactions, Induction period. Chain reactions and explosion limits. Reactions in solution, Factors affecting the rates in solutions, effect of solvation and Internal pressures, Double and Single sphere models, Effect of ionic strength, Bronsted-Bjerrum equation, Numerical Problems.

Unit - III

Linear Free energy Relationships: Effect of substituents on reaction rates, Basic idea of linear free energy relationships particularly Hammett, Taft, Brown and Okamoto, Sekigawa and Van - Bakkum plots (Introductory treatment only).

Unit - IV

Catalysis: Acid- Base catalysis, Acidity function, Enzyme -catalysis, Michaelis-Menten equation.

Photochemistry: Jabolinskii diagram, fluorescence, phosphorescence, chemiluminiscence and photosensitization, photophysical kinetics of unimolecular process.

Unit - V

Macromolecules : Explaining the terms Isotactic, Atactic, Syndiotactic, Copolymers, Block copolymers, Linear, Branched and Cross linked polymers, Addition and condensation polymerisation. Degree of polymerisation and length of polymer chains. Requirement of purity for synthesis. Molecular weights and their distribution. Polydispersity. Determination of molecular weight by Osmotic pressure, Viscosity, light scattering and sedimentation equilibrium methods.

Suggested Readings :

1. Chemical Kinetics by: K.J. Laidler
2. Enzyme Kinetics by: D.V. Roberts
3. Text book of Physical Chemistry by: S. Glasstone
4. Chemical Kinetics by: Ralphe Jr. Westron and A.S. Harold
5. Physical Chemistry by: G.M. Barrow
6. Physical Chemistry by: G.W. Castellan

7. Introductory Polymer Chemistry by: G.S. Misra
8. Physical Organic Chemistry by: N.S. Issacs

COURSE OBJECTIVES:

1. Third order reactions, Theories of reaction rates, 3-d Potential energy surface diagrams, Col, Contour diagrams
2. Complex reactions, salt effect and solvent effect in Reactions
3. Linear Free Energy Relationships
4. Catalysis and Photochemistry
5. Macromolecules

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO1: Discuss kinetics of 3rd order reactions, collision and activated state theory for reaction rates and potential energy surfaces for a reaction.
CO2: Explain the effect of different parameters on reaction rates as ionic strength, solvent, catalyst and temperature on reaction rates.
CO3: Deduce a linear relationship between substituents and change in free energy of a reaction series.
CO 4:Familiarize with the processes such as fluorescence, phosphorescence and photochemical reactions etc.
CO5:Gain knowledge of macromolecules about their types, polymerization and methods to determine their molecular weight, polydispersity etc.

Mapping of Course outcomes (Cos) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1	X				X	X		X
CO 2	X				X	X		X
CO 3	X							X
CO 4	X		X					X
CO 5	X		X		X			X

Course Title: Chemistry Elective: Computer Applications in Chemistry *w.e.f. the session 2022-23 and onwards*	
Class: M.Sc. Pt.-I / Semester-I	**Course code: MCH-E104**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

NOTE: The question paper shall consist of Two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer (about 150 words) type questions of SIX marks each and student shall be required to attempt any five questions. Sec.-B shall contain 08 descriptive type questions of TEN marks each and student shall be required to attempt any four questions. Both sections shall have questions from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

COURSE CONTENTS:

Unit - I

Introduction to Computers: Block diagram of computers; Input and output devices-key board, mouse, scanner, VDU, plotter, Types of printers; Primary & secondary memory - RAM, ROM, Secondary Memory devices-Hard Disk, CD, Flash Drive and Memory card; Volatile and non-volatile memory; CPU - ALU and control unit; Hardware & software, Software - system software and application software.

Unit – II

Programming Languages, Number System and Operating System: Introduction to Algorithms and Flow charts, Programming languages - Machine, Assembly and high level language. Number System: Bits and Bytes, Decimal, binary and octal number system and their arithmetic. Operating system and its functions: Microsoft windows. Applications of Microsoft Office, Google classroom and Google meet.

Unit - III

C Programming: Introduction; Style of C language; Character set; keywords, data types, variables and constants in C; Operators-Arithmetic, Relational, Logical, Bitwise, Ternary, Cast and Sizeof operators in C; Input and output statements in C language; Control and conditional statement in C; break and continue statement in loop. Storage classes in C; Functions (built in and user defined): Introduction to arrays.

Unit - IV

Computer applications in Physical and Analytical Chemistry: Listing the C- program for the following: Determination of rate constant of first order reactions, determination of rate constant for second order reactions, study of rate constant with variation of ionic strength, obtaining the heat of reaction using Hess's law of constant heat summation, obtaining the heat of reaction at different temperatures using Kirchoff's equation. Determination of Normality, Molarity and Molality of solutions, Determination of concentration using Beer- Lambert's law.

Unit - V

Computer applications in Inorganic and Organic Chemistry:

Listing the C-program for the following: Determination of electronegativity of an atom from bond energy data using Pauling relation, determination of half life and average life of a radioactive nucleus. Determination of empirical formula of hydrocarbons and other organic compounds, Determination of molecular weights of organic compounds, Determination of molecular weights of organic compounds by Cryoscopic and ebullioscopic method. Determination of isoelectric point of amino acids.

Chemdraw software and its applications.

Suggested Readings:

1. Fundamentals of computer by V. Rajaraman
2. Programming in C (Schaum series outline) by Gotterfried.
3. "Computers in Chemistry" by K.V. Raman
4 Computer fundamentals and programming in C by Reema Thareja (2nd Edition)

COURSE OBJECTIVE:

The present course shall enable the students to gain knowledge about:

1. The computers, number system, operating systems.
2. The programming languages especially C-Language
3. The applications of computers in chemistry.
4. Working/operation of modern software based instruments.

COURSE OUTCOMES:

On completion of this course, student shall be able to:
CO 1: Understand the fundamentals and working of computer system.
CO 2: Enable to develop the simple programming in 'C' language.
CO 3: Apply the programming of 'C 'language in Physical, organic, inorganic and analytical Chemistry.
CO 4: Knowledge of software systems and application in software based modern instruments.
Mapping of Course outcomes (Cos) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1				X				X
CO 2				X			X	X
CO 3				X			X	X
CO 4		X	X	X				X

Course Title: Lab Course: 1 *w.e.f. the session 2022-23 and onwards*	
Class: M.Sc. Pt.-I / Semester-I	**Course code: MCH-C151**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

Hands On Experiments

A. Inorganic Chemistry:

(a) Analysis of inorganic mixture for 08 ions including 04 cations. Special emphasis may be given on dry tests and spot tests (including rare earths).

(b) Preparation of the following complexes and determination of their composition by volumetric and Gravimetric techniques ;

(i) Nickle complexes with ethylene diammine and mono or diketones.

(ii) Cobalt Pentammine Chloride. $[Co(NH_3)_5\ Cl]Cl_2$

(iii) Tris acetyl acetonate Fe (III).

(iv) Reactions of Transition Metals - A Laboratory Exercise to Study the Different Oxidation States of Vanadium By their Quantitative Evaluation.

(v). Tris acetyl acetonate Mn (II).

(c) Gravimetric analysis of two metal ions given in a mixture.

B. Organic Chemistry:

(i) Separation of organic mixture and identification, confirmation by derivative preparation as far as possible.

(ii) Two step preparations of the organic compounds involving the reactions oxidation, reduction, hydrolysis, nitration.

(iii) Estimation of Phenolic group in Phenol and Amino group in Aniline (Volumetrically).Estimation of Carboxylic group and Glucose.

(iv)Estimation of N, S and Halogens.

Distribution of Marks:

Experiment 1: 25 Marks

Experiment 2: 25 Marks

Practical Record: 10 Marks

Viva-voce: 10 Marks

COURSE OBJECTIVES:

Moles, Equivalents, Oxidation Number, Different ways to express concentration or strength of solutions. Law of Equivalance and its use in titrations.

Note: The experiments enlisted in this paper shall be described and instructions shall be given for the same. Lab manuals for the experiments shall be made available to the students.

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Illustrate the preparation of inorganic complexes.

CO 2: Relate the step wise procedure to predict the anions and cations of the metals by using step wise procedure with the aid of semi- micro qualitative analysis.

CO 3: Develop the skills to separate organic compounds from mixture by laboratory separation techniques and apply their applications in compound analysis

CO 4: Determine the amount of a reactant quantitatively using gravimetric procedure.

Mapping of Course outcomes (COs) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1		X	X					X
CO 2		X	X		X			X
CO 3		X	X		X			X
CO 4		X			X			X

Course Title: Lab Course: 2 *w.e.f. the session 2022-23 and onwards*	
Class: M.Sc. Pt.-I / Semester-I	**Course code: MCH-C152**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

Hands On Experiments:

A. Physical Chemistry: Experiments related to following techniques:

(1) Cryoscopy (2) Ebullioscopy (3) Phase rule (4) Distribution Law
(5) Adsorption (6) Chemical Kinetics (7) Thermochemistry

B. Computer Applications: Handling of computer with MS Word and Power point presentation. Internet and its application in Chemistry. Simple programming in C and C-programs related to computer applications in Chemistry.

Distribution of Marks:

Experiment 1: 25 Marks

Experiment 2: 25 Marks

Practical Record: 10 Marks

Viva-voce: 10 Marks

COURSE OBJECTIVES:

Refreshing the knowledge related to Depression of F.P./ M.P., Elevation of B.P., Phase rule, Distribution Law, different type of Adsorption, Rate of Reaction, Rate Constant, Molecularity and order of reaction, Pseudo order reactions. Methods for determination of Rate of reaction. Different type of Heat changes. Explaining the terms used in computers.

Note: The experiments enlisted in this paper shall be described and instructions shall be given for the same. Lab manuals for the experiments shall be made available to the students.

COURSE OUTCOMES:

On completion of this course, student shall be able to:
CO 1: To illustrate the Depression of F.P./ M.P., Elevation of B.P., Phase rule, Distribution Law, different type of Adsorption, Rate of Reaction, Rate Constant, Molecularity and order of reaction, Pseudo order reactions. Methods for determination of Rate of reaction. Different type of Heat changes.
CO 2: Knowledge of computer handling and MS-office.
CO 3: Learning about simple programming in ‘C’ language.
CO 4: To apply ‘C’ programming in different fields of xchemistry.

Mapping of Course outcomes (COs) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1		X	X		X			X
CO 2				X	X		X	X
CO 3		X			X		X	
CO 4					X		X	X

Course Title: Chemistry Core-1: General Inorganic Chemistry and Related Techniques of Analysis *w.e.f. the session 2022-23 and onwards*	
Class: M.Sc. Pt.-I / Semester-II	**Course code: MCH-C201**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

NOTE: The question paper shall consist of Two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer (about 150 words) type questions of SIX marks each and student shall be required to attempt any five questions. Sec.-B shall contain 08 descriptive type questions of TEN marks each and student shall be required to attempt any four questions. Both sections shall have questions from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

COURSE CONTENTS:

Unit - I

Interaction of radiation with matter:
Units of Radioactivity(Ci, Ru, Bq, Specific activity), units of radiation energy(rad, Gray,Röntgen, RDE, REM, Sievert),Measurements of activity, Geiger Muller counter, Proportional and scintillation counters, Application of Radioactive tracers, Isotopic dilution (IDA)and activation analysis(NAA).

Unit – II

Raman Spectroscopy :
Base Concepts of Raman Spectroscopy, Principle, instrumentation and applications. Fundamentals of ESR spectrum, E.S.R. spectra of transition metal complexes, spin Hamiltonian, Instrumentation and application of E.S.R. spectroscopy. **Unit - III**
Principle, instrumentation and applications of Atomic absorption spectroscopy and atomic emission spectroscopy, flame photometric methods of estimation of alkali and alkaline metals, Nephelometry and Turbidimetry.

Unit - IV

Thermal Analytical methods :
Scope, classification, Principles, instrumentation and applications of Thermo gravimetric analysis, Differential thermal analysis and differential scanning calorimetry. Thermometric titrations.

Unit - V

Inductively Coupled Plasma:
Principle, Technique, Instrumentation and Applications. Analysis of mineralogical samples, Analysis of water, Applications in biological systems.

Suggested Readings:

1. Instrumental Methods of Chemical Analysis by: G.W.Ewing, Mc Graw Hill Book Company
2. A Text book of Quantitative Inorganic Analysis by: A.I.Vogel
3. Inorganic Thermogravimetric Analysis by: Duval
4. Modern Methods of Chemical Analysis by: R.L.Pecsok and L.D.Shields
5. Thermal Analysis by: Antonin Blazek

COURSE OBJECTIVES:

1. Interaction of radiation with matter
2. Raman Spectroscopy

3. Atomic absorption spectroscopy, Atomic emission spectroscopy, Nephelometry and Turbidimetry
4. Thermal Analytical methods
5. Inductively Coupled Plasma technique

COURSE OUTCOMES:

On completion of this course, student shall be able to:
CO 1: Categorize units of radioactivity on the basis of their practical utility. At the same time acquaintance to different techniques and apparatus for detection and measurement of radioactivity enhancing the knowledge in the field of nuclear chemistry.
CO 2: Understand the principle Recognize all components of the following instruments: Raman spectrophotometer, ESR spectrophotometer, Atomic Absorption spectrophotometer, Nephelo-turbidimeter and Inductively coupled plasma and interpret data from them.
CO 3: Know the capability and disadvantages of above mentioned techniques so as to be able to choose the most suitable technique, and optimize the conditions for sample. The analytical thinking ability gets feed by studying various spectroscopic techniques.
CO 4: Have in-depth understanding the principles and practical utility of thermogravimetry, differential thermal analysis and Differential scanning calorimetry.

Mapping of Course outcomes (COs) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1	X		X		X	X		X
CO 2	X		X		X		X	X
CO 3			X		X		X	X
CO 4	X		X		X		X	X

Course Title: Chemistry Core-2: Organic Chemistry and Related Techniques of Analysis *w.e.f. the session 2022-23 and onwards*	
Class: M.Sc. Pt.-I / Semester-II	**Course code: MCH-C202**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

NOTE: The question paper shall consist of Two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer (about 150 words) type questions of SIX marks each and student shall be required to attempt any five questions. Sec.-B shall contain 08 descriptive type questions of TEN marks each and student shall be required to attempt any four questions. Both sections shall have questions from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

COURSE CONTENTS:

Unit - I

UV-Vis Spectroscopy: Electromagnetic spectrum, electronic band spectra (UV and Vis region), laws of absorption (Beer's-Lambert law), molar extinction coefficient. Types of electronic transitions, Elementary idea of chromophores, auxochromes, bathochromic and hypsochromic shifts, hyperchromic and hypochromic effects, Instrumentations and technique of UV-VIS Spectroscopy, Woodward-Fieser rules, solvent effects on π-π^* and n- π^* transitions, steric hinderance and coplanarity, Applications of UV-VIS spectroscopy. Problems pertaining to the structure elucidation of organic compounds using UV spectroscopic techniques.

Unit - II

IR spectroscopy: Vibrational rotational spectra- Principle, absorption of infrared radiation & molecular vibration-rotations. Fundamental vibration, overtones and combination tones. finger print region, infrared vibration - active and forbidden (selection rules). Instrumentation, factors affecting vibrational frequencies, spectral study of different functional groups. Idea of rotational spectrum. Problems pertaining to the structure elucidation of organic compounds using IR spectroscopic techniques.

Unit - III

NMR spectroscopy: H^1-NMR;Basic concept, instrumentation, FTNMR, chemical shift, shielding & deshielding, homotopic and diasteriotopic protons, spin-spin coupling, coupling constant, AX and AX_2 type spectra, spin decoupling, lanthanide shift reagents. C^{13}-NMR spectroscopy, off-resonance decoupling. Applications Problems pertaining to the structure elucidation of organic compounds using NMR spectroscopic techniques.

Unit - IV

Mass spectrometry: Basic principle, fragmentation pattern of major functional groups, instrumentation, Mclafferty rearrangement, metastable ions, retro Diels-Alder reaction, general applications. Problems pertaining to the structure elucidation of organic compounds using Mass spectroscopic techniques.

Unit - V

XRD, SEM and TEM:

Principle, Technique and applications of X-ray diffraction spectroscopy.Principle, technique and applications of Scanning Electron Microscopy and Transmission Electron Microscopy.

Suggested Readings:

1. Spectroscopy by: C. J. Benwell

2. Spectroscopic Identification of Organic Compounds by: Silverstein, Bassler, Morrill

3. Organic Chemistry by: Kapoor, Singh , and Mukherjee

4. Organic Chemistry by: Boyd and Morrison
5. Organic Spectroscopy by: W. Kemp
6. Organic Spectroscopy by: Jagmohan

COURSE OBJECTIVES:

1. UV-VIS Spectroscopy
2. IR spectroscopy
3. NMR spectroscopy
4. Mass spectrometry
5. XRD,
6. SEM
7. TEM

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Recognize the basic concept of Electronic and I.R. spectroscopy.
CO 2: To understand the valuable concept of NMR spectroscopy for structure elucidation of molecules
CO 3: To learn the knowledge about Mass spectrometry technique.
CO 4: Explain the application of XRD, SEM and TEM techniques.

Mapping of Course outcomes (Cos) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1	X	X	X				X	X
CO 2	X	X	X		X		X	X
CO 3	X	X	X				X	X
CO 4		X	X				X	X

O 5: Predict the structure of unknown molecule by using different spectral data.

Course Title: Chemistry Core-3: Physical Chemistry and Related Techniques of Analysis *w.e.f. the session 2022-23 and onwards*	
Class: M.Sc. Pt.-I / Semester-II	**Course code: MCH-C203**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

NOTE: The question paper shall consist of Two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer (about 150 words) type questions of SIX marks each and student shall be required to attempt any five questions. Sec.-B shall contain 08 descriptive type questions of TEN marks each and student shall be required to attempt any four questions. Both sections shall have questions from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

COURSE CONTENTS:

Unit - I

Treatment of Data in Quantitative Analysis : Accuracy, Precision, Methods for expressing the accuracy and precision, Standard deviation, Types of errors, Elimination and minimization of errors, Significant figures, Criterion for the rejection of data.

Unit - II

Signal, Noise, Sensitivity Detection Limits, FT: Elementary idea of signal to noise ratio, Sensitivity and detection limits, Types and sources of noise (Thermal, shot, Flicker and Environmental noise). Eliminations/Minimization of noise, Time domain & frequency domain plots in emission spectroscopy. Basic idea and applications of Fourier transformation.

Unit - III

Polarisation and Overvoltage: Theories of Hydrogen overvoltage, Ilkovic equation, d.m.e., Half wave potential, Diffusion current, Polarography and its simple and general applications.(Specific applications not required)

Ion Exchange: Cation and Anion exchangers, their Stability, Selectivity and Characteristics, General applications including Ion Exchange Chromatography.

Unit - IV

Conductometric, Potentiometric and pH–metric Titrations: Theory, Technique and applications of Conductometric, Potentiometric and pH- metric titrations.

Solvent Extraction: Principles, Techniques and applications.

Unit - V

Chromatographic Techniques : Basic principles, Experimental techniques, Simple and general applications of Column, Paper, Thin layer, Gas-solid, Gas- liquid and High-Performance Liquid Chromatography (excluding specific applications).

Suggested Readings:

1. Instrumental Methods of Analysis by: Willard Merit, Dean and Seatle
2. Instrumental Methods of Chemical Analysis by: G. W. Ewing
3. Text book Physical Chemistry by: S. Glasstone
4. Hand Book of Chromatography for Chemists and Engineers by: M. K. Shingari
5. Analytical Chemistry by: I. M. Kolthoff
6. Quantitative Analysis by: Vogel
7. Qualitative Analysis by: Vogel
8. Mathematics and Statistics for Chemists by: C. J. Brooks, I. G. Betteley and S. M. Lexsten
9. Molecular Spectroscopy by: C. J. Benwell

COURSE OBJECTIVES:

1. Treatment of Data in Quantitative Analysis
2. Signal, Noise, Sensitivity Detection Limits, FT
3. Polarisation, Overvoltage, Basic Polarography
4. Ion Exchange
5. Conductometric, Potentiometric and pH–metric Titrations
6. Solvent Extraction
7. Chromatographic Techniques

COURSE OUTCOMES:

On completion of this course, student shall be able to:
CO1: To discuss about the accuracy, precision, errors, significant figures and criteria about the rejeton of data.
CO2:To describe signal to noise ratio, sensitivity and detection limit and FT in emission spectroscopy
CO3:To understand the concept of polarization, overvoltage and polarographic technique in analysis in qualitative and quantitative analysis.
CO4: Familiar with ion exchange and solvent extraction technique for the analysis of various samples of daily use.
CO5: Able to gain knowledge of basic principle, technique and applications of conductometric, potentiometric and pH-metric titrations.
CO6: To explain principle, experimental technique and simple and general applications of paper, column, thin layer, gas solid, gas liquid and high performance liquid chromatography.

Mapping of Course outcomes (Cos) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1	X	X			X			X
CO 2	X				X			X
CO 3	X		X			X		
CO 4	X							X
CO 5	X		X					X
CO 6	X		X					X

Course Title: Chemistry Elective: Chemistry in Vedic Literature and Ayurvedic Drugs *w.e.f. the session 2022-23 and onwards*	
Class: M.Sc. Pt.-I / Semester-II	**Course code: MCH-E204**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

NOTE: The question paper shall consist of Two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer (about 150 words) type questions of SIX marks each and student shall be required to attempt any five questions. Sec.-B shall contain 08 descriptive type questions of TEN marks each and student shall be required to attempt any four questions. Both sections shall have questionsfrom the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

COURSE CONTENTS:

Unit - I

Chemistry in vedic literature and Indian philosophy-I:

Kanad's atomic theory, Concept of Parmanu, Formation of molecules, Parimandal, Comparison with Dalton's atomic theory and models of Thomson, Rutherford and Bohr. Concept of SAMATA and VISHAMTA Vs Maxwell-Boltzmann's distribution of velocities and energies.

Unit - II

Chemistry in vedic literature and Indian philosophy-II:

First and Second law of thermodynamics in daily life. Law of helplessness of mankind in thermodynamics and Indian philosophy. Entropy in life and concept of Pralaya.Dhananjay Vs Concept of Radioactivity – Life after death. Atomic Spectrum Vs Concept of Kundalini. **Unit – III**

(a) Metallic Medicines in Ayurveda: Shodhan and Marna, Doshas of Mercury and Astadasa sanskara.

(b) Pharmacodynamics of Ayurvedic drugs: Brief description of Rasa, Guna, Vipaka, Virya, and Prabhava.

Unit - IV

(a) Classification and Constituents of Crude Drugs: Brief and introductory idea of drug constituents and their Morphological, Chemical and Pharmacological classification.

(b) Plant Analysis : Methods of extraction, Isolation separation and identification of various constituents (Introductory description). Isolation of Caffine from Tea leaves, Isolation of Piperine from black piper and Isolation of curcumine from turmeric.

Unit - V

(a) **Analysis of Ayurvedic Drugs**: General idea of analysis of active constituents and standarization of Ayurvedic drugs, namely Rasa, Bhasma, Pisti and Herbs.

(b) **Analysis of Modern drugs**: Assay and identification of Aspirin, Ibuprofen, Quiniodochlor, Diclofenac, Ascorbic acid, Paracetamol and chloroquine phosphate.

Suggested Readings:

1. Alchemy and Metallic Medicines in Ayurveda by: Vaidya Bhagwan Das
2. History of Hindu Chemistry by: P. C. Ray
3. Ayurvediya Rasa Shastra by: Siddhinandan Misra
4. Ayurvediya Rasa Shastra by: Dr. Chandra Bhushan Jha
5. Indian Alchemy by: Dr. S. Mahdihassan
6. Indian Pharmacopoea 2010
7. Text Book of Pharmacognosy by: Mahammed Ali
8. Rasajalnidhi Vol. I - III
9. Ancient Scientists of India by Satya Prakash
10. Phytochemical Methods by: J. B. Harborne (Chapmann & Hall)

11. Vaisheshik Darshan by Kanad

COURSE OBJECTIVES:

1. Chemistry in Vedic literature and Indian philosophy
2. Metallic Medicines in Ayurveda
3. Pharmacodynamics of Ayurvedic drugs
4. Classification and Constituents of Crude Drugs
5. Plant Analysis
6. Analysis of Ayurvedic and Modern drugs

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Pursue "philosophy of life" by itself as one of the Indian knowledge systems and understanding Vedic worldview as the context of various Indic knowledge disciplines.
CO 2: Perceive the Vedic outlook regarding life in the here and hereafter and the cycle of life
CO 3: Commemorate the comprehensive and seamless nature of Vedic knowledge. Understand the concepts of *Svadharma*, free will and duty oriented action.
CO 4: Understand the purpose and utility of Vedic knowledge systems in enriching human life comprehending the Vedic world view of knowledge, its purpose and its universal and holistic nature
CO 5: Correlate the Ancient Indian System of knowledge with role of Chemistry in Modern Living.
CO 6: Grasp of vocabulary, models used and the process and practice of Chemistry as a Science in context to *Rasasastra*.
CO 7: Gain knowledge of ayurvedic system of medicine by studying various aspects of herbs and natural products. Deduce knowledge in analysis of drugs of ayurvedic and allopathic nature as well in order to infer regarding the pharmacodynamics of drugs in a better way.

Mapping of Course outcomes (COs) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1				X			X	
CO 2				X			X	
CO 3				X			X	
CO 4				X			X	
CO 5	X			X			X	X
CO 6	X		X	X			X	X
CO 7	X		X	X	X		X	X

Course Title: Lab Course: 1 ***w.e.f. the session 2022-23 and onwards***	
Class: M.Sc. Pt.-I / Semester-II	**Course code: MCH-C251**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

Hands On Experiments

Experiments involving the extensive handling of apparatuses and equipments related to following techniques: Polarimetry, Refractometry, Spectrophotometry, Turbidimetry/ Nephelometry, D.O. analyser, Column chromatography, Paper chromatography, Thin layer chromatography, Gas-Liquid chromatography, Flamephotometry.

Distribution of Marks:

Experiment 1: 25 Marks

Experiment 2: 25 Marks

Practical Record: 10 Marks

Viva-voce: 10 Marks

COURSE OBJECTIVES:

Basic Idea of Calibration Curves, Angle of rotation, Refractive Index, Absorbance, Bear-Lambert Law, Molar extinction constant, Absorption Maxima, Turbidity, D.O., Principle and Methodology for Column, Paper and Thin Layer Chromatography, AAS and AES.

Note: The experiments enlisted in this paper shall be described and instructions shall be given for the same. Lab manuals for the experiments shall be made available to the students.

COURSE OUTCOMES:

On completion of this course, student shall be able to:
CO 1:Learn to draw calibration curve and to calculateAngle of rotation, Refractive Index, Absorbance, Molar extinction constant, Absorption Maxima
CO 2: Analyse samples using techniques as Polarimetry, Refractometry, Spectrophotometry, Turbidimetry/ Nephelometry, D.O. analyser, Flamephotometry.
CO 3: Gain knowledge of basic principle, instrumentation and separation byColumn chromatography, Paper chromatography, Thin layer chromatography and Gas-Liquid chromatography.

Mapping of Course outcomes (Cos) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1		X	X				X	X
CO 2		X	X				X	X
CO 3		X	X				X	X

Course Title: LabCourse: 2 *w.e.f. the session 2022-23 and onwards*	
Class: M.Sc. Pt.-I / Semester-II	**Course code: MCH-C252**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

Hands On Experiments:

A. Experiments related to pH metry, Conductometry, Potentiometry & Polarography Electrophoresis, Fluorimetry and Interferrometry.

B. The experiments related to the analysis of Ayurvedic and Allopathic Drugs.

Distribution of Marks:

Experiment 1: 25 Marks

Experiment 2: 25 Marks

Practical Record: 10 Marks

Viva-voce: 10 Marks

COURSE OBJECTIVES:

Discussion on pH scale, its temperature dependence, limitations of scale, Buffers. Different type of Conductance and effect of dilution on conductances. Single electrode Potential, Nernst Equation for single electrode potential, Notations for Galvanic and electrolytic cells, Representing Galvanic Cells, writing equations for E_{cell}. Polarography, half wave potential, Illkovic equation and using it for qualitative and quantitative analysis. Basic principle of fluorimetry and Interferrometry.

Note: The experiments enlisted in this paper shall be described and instructions shall be given for the same. Lab manuals for the experiments shall be made available to the students.

COURSE OUTCOMES:

On completion of this course, student shall be able to:
CO 1: Develop the key practical skills in pH-metry, Conductometry, Potentiometry, Polarography, Electrophoresis and Flourimetry likewise.
CO 2: Demonstrate the setup of the potentiometer and learn about the standard reduction potential table and how each potential value was determined.
CO 3: Recognize types of electrodes and determine when they should use each one. Learn pH meter and how does it work, including the functions of the parts of the sensor. Recognize errors and be precautions when using different electrodes.
CO 4: Analyze drugs related to ayurvedic and allopathic origin to establish their purity and their compatibility for human consumption.

Mapping of Course outcomes (COs) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1		X	X		X			X
CO 2		X	X		X			X
CO 3		X	X		X			X
CO 4		X	X	X	X	X		X

Course Title: Chemistry Core-1:Analysis of Water and Waste Water *w.e.f. the session 2023-24 and onwards*	
Class: M.Sc. Pt.-II / Semester-III	**Course code: MCH-C301**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

NOTE: The question paper shall consist of Two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer (about 150 words) type questions of SIX marks each and student shall be required to attempt any five questions. Sec.-B shall contain 08 descriptive type questions of TEN marks each and student shall be required to attempt any four questions. Both sections shall have questions from the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

COURSE CONTENTS:

Unit - I

Sampling and storage of water samples. Analysis of water samples for the following: Colour, Odour, Taste, turbidity, conductivity, total solids, filterable, nonfilterable, fixed and volatile solids, pH, total alkalinity, CO_3^{--} and HCO_3^{-} alkalinity, acidity, B.O.D., C.O.D. and D.O.

Unit - II

Chemical Analysis of Water samples: Chemical Analysis of Water samplesfor NH_3, NO_3, NO_2, organic N, total N, Inorganic phosphates, silica, SO_4^{--}, Hardness (Ca and Mg) Na, K, residual Chlorine.

Unit - III

Optimum alum dose and it's determinations

Bacteriological Examination of Water: Preparation of culture media and nutrient-agar.Total counts and Coliform MPN with interpretation of test data from Industrial and Municipal points of view (Potability of water).

Unit - IV

Basic idea of D.C., A.C. and pulse polarography, stripping and cyclic Voltametry. Their basic applications with particular reference to analysis of water and waste water.

Unit - V

Potentiometric Determination of Pb in water. Water Pollution, effluent treatment. Suitability of treated water for agricultural/municipal supplies and industries. Water quality standard parameters (WHO and BIS).

Suggested Readings:

1. Standard Methods for Examination of water and Waste water by: APHA
2. Commercial Methods of Chemical Analysis by: F. D. Snell and F. M. Biffen
3. Chemical and Biological Method for Water Pollution Studies by: R. K.Trivedi and P. K. Goel
4. Water and Waste water Testing- A Laboratory Manual by: R. P. Mathur
5. Indian Standards for water Analysis (I. S. I.Publications)
6. Environmental Chemistry by: A. K. De
7. Environmental Pollutional Control Engineering by: C. S. Rao

COURSE OBJECTIVES:

1. Sampling, storage and Physico-chemical analysis of water samples
2. Bacteriological Examination of Water
3. Polarography (D.C., A.C. and pulse), stripping and cyclic Voltammetry with particular reference to analysis of water and waste water

4. Water Pollution, Effluent treatment and Water quality standard parameters

COURSE OUTCOMES:

On completion of this course, student shall be able to:
CO 1: Understand the importance of analysis of water.
CO 2: Knowledge of the chemicals present in water by Physico-chemical analysis.
CO 3: Describe about Bacteriological analysis of Water.
CO 4: To grasp the awareness about the pollution of water
CO 5: To create the ideas and concepts for water treatment process.

Mapping of Course outcomes (Cos) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1	X		X			X	X	X
CO 2	X		X			X	X	X
CO 3			X			X	X	X
CO 4	X		X			X	X	X
CO 5			X			X	X	X

Course Title: Chemistry Core-2: Analysis of Soil *w.e.f. the session 2023-24 and onwards*	
Class: M.Sc. Pt.-II / Semester-III	**Course code: MCH-C302**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

NOTE: The question paper shall consist of Two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer (about 150 words) type questions of SIX marks each and student shall be required to attempt any five questions. Sec.-B shall contain 08 descriptive type questions of TEN marks each and student shall be required to attempt any four questions. Both sections shall have questionsfrom the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

COURSE CONTENTS:

Unit - I

(a) Phases Present in the soil: Soil air, Soil solution and solids, Factors affecting the composition and concentrations of the salts in the soils.

(b) Inorganic Portion of the Soil: Primary and secondary minerals, crystalline silicate, and Aluminosilicates, Amorphous substances & salts, Relation of particle size and texture with the nutrients present in the soil.

Unit - II

Organic Portion of the Soil: Variable nature, Non - Humified organic part, Humic substances (Humic Acids, Fulvic Acids and Humins). (only elementary knowledge of soil composition is required).

Soil sampling : Handling, transport, and storage of samples, seiving and grinding.

Unit - III

Physical Analysis of soil: Analysis of soil samples for the porous nature, Water absorbing capacity, Moisture contents, Loss on Ignition, pH and conductivity.Cation exchange capacity and its determination.

Unit - IV

Chemical Analysis of Soil :

Chlorides, Sulphates, Total alkalinity, soluble carbonates and Biocarbonates, Available phosphorus, total organic matter (by modified Walkley and Black Methods), Nitrogen by Kjeldahl digestion method, available nitrogen, exchangeable sodium and potassium.

Unit - V

Determination of exchangeable Hydrogen and Lime requirement. Determination of Gypsum requirement and water soluble salts in saline and alkaline soils.

An elementary idea of Chemical analysis as a measure of soil fertility. Interpretation of soil taste data with reference to different crops.

Suggested Readings:

1.Standard Methods for Chemical Analysis Vol. III (VI edition) Instrumental Methods Part – B by: Frank J. Welcher
2. Agricultural Chemistry Vol. I by: B. A. Yogdin
3. Practical Manual for Introductory Courses in Soils by: Haryana Agricultural University
4. Chemical and Biological Methods for water polution Studies by: R. K. Trivedi and P. K. Goel
5. Soil Chemical Analysis by: M. L. Jackson
6. USDA handbook to Diagnosis and improvement of Saline alkali soils by: I. B. M., New Delhi

COURSE OBJECTIVES:

1. Phases Present in the soil
2. Inorganic and organic portion of the Soil
3. Soil Sampling and storage
4. Physical and Chemical analysis of soils
5. Exchangeable Hydrogen
6. Lime and Gypsum requirement
7. Interpretation of soil test data for crops

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: To gain knowledge about composition of soil in terms of different phases, organic and inorganic minerals present in the soil.
CO 2: To do sampling, storage and physico-chemical analysis of soil samples by some conventional and modern methods of analysis.
CO 3: To explain principle and method of determination of exchangeable hydrogen in soil.
CO 4: To calculate the amount of lime requirement and gypsum requirement of the soil
CO 5: The student becomes capable to prepare report base on the experimental results and interpret the soil test data for particular crop/crops and fertilizer recommendation.

Mapping of Course outcomes (Cos) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1	X		X					X
CO 2	X					X		X
CO 3	X					X		X
CO 4	X					X		X
CO 5	X				X			X

Course Title: Chemistry Core-3:Analysis of Oils, Fats, Soaps, Detergents, Essential oils, Paints and Varnishes *w.e.f. the session 2023-24 and onwards*	
Class: M.Sc. Pt.-II / Semester-III	**Course code: MCH-C303**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

NOTE: The question paper shall consist of Two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer (about 150 words) type questions of SIX marks each and student shall be required to attempt any five questions. Sec.-B shall contain 08 descriptive type questions of TEN marks each and student shall be required to attempt any four questions. Both sections shall have questionsfrom the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

COURSE CONTENTS:

Unit - I

Oils and Fats: General idea, Classification, Occurrence, Basic idea of the function of oils and fats, Physical and chemical properties of oils and fats, Applications of oils and fats.

Soaps and detergents : Idea of common soaps, Cleansing action of soaps, Varities of soaps and their uses, Idea of detergents, Hazards of soaps and detergents.

Unit - II

Analysis of oils and fats: Determination of physical constants like M.P. and B.P., Specific gravity, Refractive index, Total volatile matter, Determination of Acid value, Iodine value, Saponification value, R.M. value and Polenske number.

Unit - III

Analysis of soaps and detergents: Determination of Matter insoluble in alcohol, Free alkali and free acids, Matter insoluble in water, Glycerol content (Dichromate method), Foaming capacity and its comparision in different samples of soaps and detergents, Effect of sodium carbonate on the foaming capacity of soap.

Unit - IV

Essential Oils: Introduction, nomenclature, constituent terpenoid. Isolation, separation of terpenoids from essential oils. General properties of terpenoids. Isoprene & Special Isoprene rule, Gem-dialkyl rule, Classification of terpenoids, Citral, Geraniol, Nerol, Linalool and Menthol, including constitution.

Unit - V

Paints, Varnishes and Lacquers: General introduction of organic protective coatings, Essential ingradients of paints, Important functions of a pigment, a filler, a vehicle, a thinner, extenders, solvents and diluents, film forming materials and binders, distampers, plastisizers, emulsion paints, oil paints, epoxy paints, alkyd resins, phenolic resins, urea-formaldehyde and malamine-formaldehyde resins. Lacquers, drying, oxidative drying, curing, stoving, coatings, cold curing coatings. Various defects on paint surfaces and their rectification.

Suggested Readings:

1. Methods of Sampling and Test for oils and fats, I.S.I, New Delhi
2. Methods of Sampling and Test for soaps and detergents, I.S.I, New Delhi
3. Organic Chemistry by Kapoor, Singh and Mukherjee
4. Organic Chemistry of Natural Products Vol. I and II by: Chatwal
5. Chemistry in Engineering and Technology by: Kuriacose and Raja Ram

COURSE OBJECTIVES:

1. General idea of Oils, Fats, Soaps and detergents

2. Analysis of Oils, Fats, Soaps and detergents
3. Essential oils
4. Paints, Varnishes and Lacquers

COURSE OUTCOMES:

On completion of this course, student shall be able to:
CO 1: Gain fundamental knowledge on basics of chemistry involved in the oils/ fats especially in context of drying Oils. Implement different modes of derivatizations of oils/ fatty acids along with studying the basic process of analysis of oils\ fats.
CO 2: Understand the basics of soaps, surfactants and detergents and Able to explain the composition of soaps and detergents. Interpret the effect of use of new generation of surfactants in formulation and comment on quality standards of soaps, surfactants and detergents.
CO3: Learn the isolation and extraction process along with properties and chemical synthesis of some bio-active natural products. Explain the general methods in structure determination of terpenoids. Understand the fundamental knowledge on perfumery chemicals with an extended application in the field of pharmaceuticals.
CO 4: Classify different types of organic coatings on the basis of its properties and applications. Understand fundamental knowledge on basics of chemistry involved in the Paints. Summarize various defects, their causes and cure surfacing out on application of different paints.

Mapping of Course outcomes (COs) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1	X		X			X		X
CO 2	X		X			X		X
CO 3	X		X					X
CO 4	X		X			X		

Course Title: Elective: Analysis of Cement, Minerals, Alloys, Trace Metals and Polymers *w.e.f. the session 2023-24 and onwards*	
Class: M.Sc. Pt.-II / Semester-III	**Course code: MCH-E304**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

NOTE: The question paper shall consist of Two sections (Sec.-A and Sec.-B). Sec.-A shall contain 10 short answer (about 150 words) type questions of SIX marks each and student shall be required to attempt any five questions. Sec.-B shall contain 08 descriptive type questions of TEN marks each and student shall be required to attempt any four questions. Both sections shall have questionsfrom the entire syllabus. The previous year paper/model paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

COURSE CONTENTS:

Unit - I

Analysis of Limestone, Dolomite and Talcum powder: Loss on ignition, Impure silica or insoluble matter, combined oxides (AI_2O_3 + Fe_2O_3), Calcium oxide, Magnesium oxide, Carbondioxide, Volumetric procedure for the determination of calcium and Magnesium (EDTA Titration).Analysis of talcum powder: Determination of Ca and carbon dioxide in $CaCO_3$, Determination of Mg in Magnesium sulphate, Determination of phosphate in sodium phosphate.

Unit - II

Cement: Introduction, Portland cement, Manufacture (Outline), sampling, standard methods of chemical analysis of Portland cement, setting and hardening, Gypsum, Plasters and their setting, Weathering of cement and concrete, Chemical admixtures of concrete, other types of cement.

Unit - III

Analysis of steels and alloys: Determination of carbon by volumetric method, Determination of silicon by gravimetric method, Determinationof Mn by the Bismuthate method, Determinationof P, V, and Cr in alloyed steels, Determinationof Iron in iron ore.Analysis of brass, Nickel coin, slag and fluxes.Determination of Zn by ferrocyanide method.

Unit - IV

Colorimetry and spectrophotometry in trace metal analysis :

General aspects of Inorganic colorimetric trace analysis, Methods for the separation and isolation of traces of elements, General colorimetric reagents, Procedure for the determination of traces of metals viz; As, Cu, Cr, Pb and Ni.

Unit – V

Synthesis and Analysis of polymers: Purification of monomer, polymerization technique, synthesis of polymer of acrylonitrile, styrene, methyl methacrylate, ethylene glycol with maleic acid, Terephthaloyl chloride with ethylene diamine.

Isolation and purification of polymers. Determination of glass transition temperature and Molecular weight.Determination of viscosity, pH, electrolytic stability, Hardness, tensile strength, percentage elongation of polymers.

Suggested Readings:

1. Analytical Chemistry in Metallurgy (Mir publishers) by: V. I. Posypanko and N. A. Vasina
2. Industrial Chemistry by: B. K. Sharma
3. Quantitative Inorganic Analysis by: Vogel
4. Chemistry in Engineering & Technology by: R. Ram & Kuriacose
5. Colorimetric determination of traces of metals by: E. B. Sandell

COURSE OBJECTIVES:

1. Analysis of Limestone, Dolomite and Talcum powder
2. Cement and its analysis
3. Analysis of Steels and Alloys
4. Trace metal analysis by colorimetric and spectrophotometry
5. Synthesis of polymers

COURSE OUTCOMES:

On completion of this course, student shall be able to:
CO 1: To impart knowledge of qualitative and quantitative analysis of limestone, dolomite and talcum powder.
CO 2: To discuss about Portland cement, cement, gypsum, admixtures, standard methods of chemical analysis of cement etc.
CO 3: To develop the ability to analyze the steel sample for its component elements.
CO 4: To describe the general aspects of Inorganic colorimetric trace analysis with some specific examples, Methods for the separation and isolation of traces of elements, General colorimetric reagents,
CO 5: To explain synthesis, analysis, polymerization, isolation and separation and physico-chemical properties of polymers.
Mapping of Course outcomes (Cos) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1	X		X					X
CO 2	X		X					X
CO 3			X		X			X
CO 4	X				X			X
CO 5	X					X		X

Course Title: Lab Course: 1 ***w.e.f. the session 2023-24 and onwards***	
Class: M.Sc. Pt.-II / Semester-III	**Course code: MCH-C351**
Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

Hands On Experiments:

A. Analysis of water and waste water.
B. Analysis of soils.

Distribution of Marks:

Experiment 1: 25 Marks

Experiment 2: 25 Marks

Practical Record: 10 Marks

Viva-voce: 10 Marks

COURSE OBJECTIVES:

Basic terms related to water and soil analysis. Explaining the origin/derivation of different formulae used in water and soil analysis.

Note: The experiments enlisted in this paper shall be described and instructions shall be given for the same. Lab manuals for the experiments shall be made available to the students.

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Learn the sampling, preservation and physico- chemical analysis of water samples.

CO 2: Gain knowledge of analysis of soil for different purposes by sampling, preservation and physico-chemical analysis.

CO 3: Interpretation of soil and water test data.

Mapping of Course outcomes (COs) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1		X	X			X	X	X
CO 2		X	X			X	X	X
CO 3		X	X			X	X	X

Course Title: Lab Course: 2*w.e.f. the session 2023-24 and onwards*	
Class: M.Sc. Pt.-II / Semester-III	**Course code: MCH-C352**

Lectures: 60	Credits : 04
MM: 70	Exam Hours: 03

Hands On Experiments:

A. ***Analysis of Oils and Fats, Soaps and Detergents.***
B. Analysis of Cement, Minerals, Alloys.
C. Experiments related to Polymers:
Synthesis of polymers: bulk polymerization of styrene, precipitation polymerization of acrylonitrile, emulsion polymerization of styrene, suspension polymerization of methyl methacrylate, polycondensation of ethylene glycol with maleic acid.
Determination of viscosity, pH, electrolytic stability, Hardness, tensile strength, percentage elongation of polymers

Distribution of Marks:

Experiment 1: 25 Marks

Experiment 2: 25 Marks

Practical Record: 10 Marks

Viva-voce: 10 Marks

COURSE OBJECTIVES:

Basic terms related to Oils and Fats, Soaps and Detergents, Cement, Minerals, Alloys and Polymers. Explaining the origin/derivation of different formulae used in their analysis.

Note: The experiments enlisted in this paper shall be described and instructions shall be given for the same. Lab manuals for the experiments shall be made available to the students.

COURSE OUTCOMES:

On completion of this course, student shall be able to:
CO 1: Analyze and illustrate physical characteristics of oils like specific gravity, refractive index, color, viscosity etc. Evaluate chemical properties like acid value, saponification value, iodine value, RM value, polenske value etc.
CO 2: Explain the significance of various tests for soaps and detergents. Implement the use of surfactants in industrial applications. Evaluate performance properties of soaps and detergents.
CO 3: Investigate the composition of cement and alloy which is of utmost importance while selecting cement formulation for specific purpose and also helps in identifying the purity of samples being tested.
CO 4: Develop practical skills in the preparation of different polymers through different polymerization techniques such as bulk, solution, suspension and emulsion in addition to characterization, testing and processing of different polymers.

Mapping of Course outcomes (COs) with Programme out comes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1		X	X		X			

CO 2		X	X		X	X		
CO 3		X	X		X	X		
CO 4		X	X		X	X		X

Course Title: Industrial Training cum Project/Dissertation Work/ Assignment *w.e.f. the session 2023-24 and onwards*	
Class: M.Sc. Pt.-II / Semester-IV	**Course code: MCH-C471**
Lectures:24	Credits : 24
MM: 600	

1. The students shall undertake project work cum industrial training at an industry/institution under the supervision of one of the teaching staff members of the department. This work shall be submitted in typed and bound form after getting signed by the student and concerned supervisor and forwarded by the Head of the Department. The placement cell of University shall help and cooperate with the Department and students for undertaking the project work at industries. The placement officer shall get a *placement cum training brochure* printed and sent to various industries/institutions in this regard.
2. A certificate by the industry/institution and another by the supervisor along with the declaration by candidate shall be attached/enclosed with the project report. *Self-declaration/ Affidavit can be submitted by the candidate in extraordinary situation like Corona spread etc in place of the certificate from Industry.*
3. Alternatively, the student can opt for undertaking dissertation work at Department of Chemistry, Gurukul Kangri University main campus or Kanya Gurukul Mahavidyalaya, Hardwar as the case may be, under the supervision of a teaching staff member and submit the same by following the same procedure as already given above for submission of project. The student shall present the Project/Dissertation work before a panel of two examiners consisting of the supervisor concerned and an expert/examiner appointed by the University. One external expert shall not evaluate more than four Projects/Dissertations. In case, an student opts for Dissertation, he/she will have to deposit an additional fee of Rs. 3000/-. The University Administration is expected to remit or provide this fee as funds additional to the regular maintenance grants of the Department so as to meet the extra expenses in this regard.
4. In extraordinary situations like Corona spread etc, the student can be given an assignment (under the supervision of a teacher from department)in the form of writing a review after literature survey in place of Industrial Project or Dissertation. Although not necessary, butthe student shall be encouraged for publishing this review in peer reviewed/ UGC CARE list journals. This Review report shall be evaluated in same way as in case of Industrial Project or Dissertation.

Distribution of Marks:

1. Pre-submission seminar (Internal Assessment) **= 180 Marks**

2. Project/ Dissertation/ Assignment Evaluation**= 420 Marks**

COURSE OBJECTIVE:

1. To provide exposure to the students with industrial/ institutional or work place environmentfor achieving their goals in professional and academic life
2. To develop problem solving skills
3. To develop awareness about handling of more sophisticated advance instruments/equipment
4. To employ the knowledge to design, carryout, report writing and data analysis.
5. To equip the students for research and development oriented skills.

COURSE OUTCOMES:

On completion of this course, student shall be able to:

CO 1: Student acquires knowledge about industry/institute work environment to achieve their goals in professional and academic life.
CO 2: Makes them capable to interact at work place in society
CO 3: Develop skills to handle analytical techniques in industry, institute and research.
CO 4: Employ the knowledge of scientific thinking to design, carryout, record and analyze the results.
CO 5: Students become equipped to step up in field of research and development.
Mapping of Course outcomes (Cos) with Programme outcomes (POs)

Course outcomes/ Programme outcomes	1	2	3	4	5	6	7	8
CO 1			X				X	X
CO 2			X				X	X
CO 3		X	X				X	
CO 4			X		X		X	X
CO 5			X				X	X