

ANNEXURE B

KANYA MAHA VIDYALAYA JALANDHAR (AUTONOMOUS)
SCHEME AND CURRICULUM OF EXAMINATION OF TWO YEAR DEGREE
PROGRAMME
Master of Science (Chemistry)
Credit Based Continuous Evaluation Grading System (CBCEGS)
(Session: 2025-26)
Semester III

Master of Science (Chemistry) Semester III										
Course Code	Course Title	Course Type	Hours Per Week L-T-P	Credits L-T-P	Total Credits	Marks				Examination time (in Hours)
						Total	Th	P	CA	
MCHL-3081	Inorganic Chemistry-II	C	4-0-0	4-0-0	4	100	70	-	30	3
MCHL-3082	Organic Synthesis	C	4-0-0	4-0-0	4	100	70	-	30	3
MCHL-3083	Surface and Polymer Chemistry	C	4-0-0	4-0-0	4	100	70	-	30	3
MCHL-3084	Photochemistry and Pericyclic reactions	C	4-0-0	4-0-0	4	100	70	-	30	3
MCHP-3085	Inorganic Chemistry Practical (Preparations)	C	0-0-6	0-0-3	3	100	-	70	30	3*2
MCHP-3086	Physical Chemistry Practical	C	0-0-6	0-0-3	3	100	-	70	30	3*2
Total					22	600				

C- Compulsory Course

Master of Science (Chemistry)
(Semester-III)
Session: 2025-26
COURSE CODE: MCHL-3081
COURSE TITLE: Inorganic Chemistry-II

Course outcomes:

Students will be able to

CO1: study about the different oxygen carriers present in the body with their structure and stereochemistry

CO2: study the bioenergetics of various biological processes in living/non living organisms and role of bio-enzymes and their functioning.

CO3: learn biochemistry of iron and detailed mechanism of nitrogen fixation reactions

CO4: learn about the different enzymes participating in the chemical reactions inside the body and their functions and role of metal ions in medicines

Master of Science (Chemistry)
(Semester-III)
Session: 2025-26
COURSE CODE: MCHL-3081
COURSE TITLE: Inorganic Chemistry-II

Time: 3Hrs

Max. Marks: 100

Credit (LTP): 4-0-0

(Theory: 70, CA: 30)

Note: The students are allowed to use Non-Programmable Calculator.

Instructions for the Paper Setters:

Eight questions of equal marks (16 each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from UNITs I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-I

Metal Ions in Biological Systems-Essential and trace elements, periodic survey of essential and trace elements, biological importance and relative abundance, Na^+ / K^+ ion pump.

Transport and Storage of Dioxygen- Oxygen carriers-Hb and Mb: Structure and mechanism of their function, co-operativity, inhibition and poisoning by ligands and metal ions, hemocyanins and hemerythrin, model complexes of iron, cobalt and copper.

UNIT-II

Bioenergetics and ATP Cycle- Process concept to phosphate hydrolysis, Nucleotide transfer-DNA polymerase, phosphate transfer pyruvate kinase, phosphoglucomutase, creatine kinase, ATPase **Photosynthesis and respiration** – chlorophyll : structure, function and its synthetic model.

Bioredox Agents and Mechanism- Enzymes and their functioning, Vitamin B_{12} coenzyme, its function and application in organic syntheses, intake of alcohol and its remedy.

UNIT-III

Biochemistry of Iron- Availability of iron, competition for iron, iron toxicity and nutrition.

Electron Transfer in Biology- Cytochromes-structure and function, CN^- and CO poisoning, Ferredoxin and rubredoxim. **Nitrogenase**- Biological N_2 fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases modelsystems.

Metal Storage, Transport- Ferritin, transferrin and siderophores.

UNIT-IV

Metalloenzymes- Zinc enzymes-carboxypeptidase and carbonic anhydrase, Copper enzymes-superoxide dismutase.

Calcium in Biology- Calcium in living cell, transport and regulation, molecular aspects of intramolecular processes,

Metals in Medicine- Metal deficiency and disease, toxic effects of antibiotics and related compounds, chelate therapy

Books Recommended:

1. Principles of Bioinorganic Chemistry, S. J. Lippard and Berg, University Science Books.
2. Inorganic Biochemistry, Vol I and II. Ed. G. L. Eichhorn, Elsevier.
3. J.E. Huheey: Inorganic Chemistry III and IV Ed. Pearson Education Asia –(2002).
4. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 5th Edition.
5. Progress in Inorganic Chemistry, Vols 18 and 38 Ed. J. J. Lippard, Wiley
6. Bioinorganic Chemistry by D. Banerjee

Master of Science (Chemistry)
(Semester-III)
Session: 2025-26
COURSE CODE: MCHL-3082
COURSE TITLE: Organic Synthesis

Course outcomes:

Students will be able to

CO1: understand general mechanistic consideration of organic rearrangements and to understand synthesis and reactions of macrocyclic compounds and fused polynuclear hydrocarbons

CO2: study the synthesis and reactions of three, four, six, seven and large membered Heterocycles

CO3: know about the use of various reagents in organic synthesis and functional group transformations

CO4: understand the basic concepts of supramolecular chemistry

Master of Science (Chemistry)
(Semester-III)
Session: 2025-26
COURSE CODE: MCHL-3082
COURSE TITLE: Organic Synthesis

Time: 3 Hrs

Max. Marks: 100

Credit (LTP): LTP: 4-0-0

(Theory: 70, CA: 30)

Note: The students are allowed to use Non-Programmable Calculator.

Instructions for the Paper Setters:

Eight questions of equal marks (16 each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from UNITs I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-I

Rearrangements: General mechanistic considerations – nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements: Pinacol-pinacolone, Wagner-Merwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofmann, Curtius, Schmidt, Baeyer-Villiger, Shapiro reaction.

Polynuclear Compounds and Macro-Ring Compounds

Introduction, comparative study of aromatic character of Linear and non-Linear-ortho-fused polynuclear hydrocarbons, ortho-and peri-fused polynuclear hydrocarbons. General method of preparation and reactions of indene, fluorene anthracene and phenanthrene.

UNIT-II

Heterocyclic Synthesis

Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reaction.

Small Ring Heterocycles

Synthesis of aziridines, oxiranes, thiiranes and their ring opening and rearrangement reactions.

Five-Membered Heterocycles with one Heteroatom

Synthesis of Furan, Pyrrole, Thiophene and their electrophilic, nucleophilic, metallation reactions.

Six-Membered Heterocycles with one Heteroatom

Pyridine synthesis (from dicarbonyl compounds, *Hantzsch Synthesis*, through *cycloaddition reactions*), reactions of pyridine (electrophilic, nucleophilic, metallation), synthesis of pyrylium salts, pyrones, benzopyrylium salts, benzopyrones (coumarins, chromones) and their electrophilic, nucleophilic and addition reactions.

Seven-and Large-Membered Heterocycles

Synthesis and reactions of azepines, oxepines, thiepin, thiazepines.

UNIT-III

Reagents in Organic Synthesis

Use of the following reagents in organic synthesis and functional group transformations; Complex metal hydrides, Gilman's reagent, lithium dimethylcuprate, lithium diisopropylamide (LDA) dicyclohexylcarbodiimide. 1,3-Dithiane (reactivity umpolung), trimethylsilyl iodide, tri-n-butyltinhydride, Woodward and Prevost hydroxylation, osmium tetroxide, DDQ, selenium dioxide, phase transfer catalysts, crown ethers and Merrifield resin, Peterson's synthesis, Wilkinson's catalyst, Baker's yeast.

UNIT-IV

Supramolecular Chemistry

Definition and development of supramolecular chemistry, Classification of supramolecular Host-Guest compounds, Historical concepts such as receptors, coordination, lock and key analogy, Chelate and Macrocyclic effects, Preorganization and Complementarity, Thermodynamics and Kinetic selectivity, Overview of intermolecular forces such as Hydrogen bonding, Hydrophobic effects, Cation- π interactions, Ion-ion, Ion-dipole, Dipole-dipole interactions, π - π stacking, van der Waals forces, Synthesis and structure of supramolecular hosts for Recognition of cations: Crown ethers, Cryptands, Spherands, Siderophores; for Recognition of anions: Guanidinium-based receptors; for Recognition of neutral molecules: Cyclotrimeratrylene (CTV).

Book Recommended:

1. Supramolecular Chemistry, Jonathan W. Steed, Jerry L. Atwood, John Wiley and Sons
2. Principles of Modern Heterocyclic Chemistry by L.A. Paquette
3. Heterocyclic Chemistry by J.A. Joule and K. Mills
4. Heterocyclic Chemistry by Gilchrist

**Master of Science (Chemistry)
(Semester-III)**

Session: 2025-26

COURSE CODE: MCHL-3083

COURSE TITLE: Surface and Polymer Chemistry

Course outcomes:

Students will be able to

CO1: study concept of adsorption and activity of catalysis at surfaces, solve numerical on BET equation

CO2: understand the concept of micelle formation, learn about CMC and thermodynamics of micellization

CO3: learn about the type and classification of polymers

CO4: know about the structure, properties and utilization of polymers, study in detail about the glass transition temperature

Master of Science (Chemistry)
(Semester-III)
Session: 2025-26
COURSE CODE: MCHL-3083
COURSE TITLE: Surface and Polymer Chemistry

Time: 3 Hrs

Max. Marks: 100

Credit (LTP): 4-0-0

(Theory: 70, CA: 30)

Note: The students are allowed to use Non-Programmable Calculator.

Instructions for the Paper Setters:

Eight questions of equal marks (16 each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from UNITs I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-I

Adsorption

Surface tension, capillary action, pressure difference across curved surface (Laplace equations), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro-kinetic phenomena), and catalytic activity at surfaces.

UNIT-II

Micelles

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

UNIT-III

Macromolecules

Polymer – definition, types of polymers, electrically conducting, fire resistant, liquids crystal polymers, kinetics of polymerization, thermodynamics of polymerization.

Molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry, diffusion and light scattering methods), sedimentation, chain configuration of macromolecules, calculations of average dimensions of various chain structures. Importance of polymers, Basic concepts: monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization: condensation, addition, radical chain-ionic and co-ordination and copolymerization. Polymerization conditions and polymer reactions. Polymerization in homogenous and heterogeneous systems. Number, weight and viscosity average weights.

UNIT IV

Structure and Properties:

Polymer structure and properties-crystalline melting point T_m -melting point of homogenous series, effect of chain flexibility and steric factors, entropy and heat of fusion. The glass transition temperature, T_g -Relationship between T_m and T_g , effects of molecular weight, diluents, chemical structure, chain topology, branching and chain linking. Property requirements and polymer utilization.

Books Recommended:

1. Physical Chemistry, P. W. Atkins.
2. Textbook of polymer science, F. W. Billmeyer Jr. Wiley.
3. Polymer science, V. R. Gowariker, N. V. Viswanathan and J. Sreedhar, Wiley-Eastern
4. Polymer Chemistry, Melcolm P. Stevens, Oxford University Press
5. Physical Chemistry of Polymers, A. Tager, Mir Publishers, Moscow

Master of Science (Chemistry)
(Semester-III)
Session: 2025-26
COURSE CODE: MCHL-3084
COURSE TITLE: Photochemistry and Pericyclic reactions

Course outcomes:

Students will be able to

CO1: classify the pericyclic reactions and explain them under thermal and photochemical conditions.

CO2: interpret the product of Pericyclic reactions (Cyclo addition, Electrocyclic and sigmatropic Reactions)

CO3: know the basic concepts of photochemical reactions and determine their reaction mechanisms

CO4: apply the knowledge of photochemical reactions of Alkenes, carbonyl compounds, aromatic compounds and to study named photochemical reactions, photochemistry of smog, polymers and vision

Master of Science (Chemistry)
(Semester-III)
Session: 2025-26
COURSE CODE: MCHL-3084
COURSE TITLE: Photochemistry and Pericyclic reactions

Time: 3 Hrs

Max. Marks: 100

Credit (LTP): 4-0-0

(Theory: 70, CA: 30)

Note: The students are allowed to use Non-Programmable Calculator.

Instructions for the Paper Setters:

Eight questions of equal marks (16 each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from UNITs I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-1

Pericyclic Reactions (A)

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene, allyl system, classification of pericyclic reactions FMO approach. Woodward-Hoffmann correlation diagrams method and Perturbation of molecular orbital (PMC) approach for the explanation of pericyclic reactions under thermal and photo-chemical conditions. Electrocyclic reactions – conrotatory and disrotatory motions, $4n$, $4n+2$, allyl systems secondary effects. Cycloadditions – antarafacial and suprafacial additions, notation of cycloadditions ($4n$) and ($4n+2$) systems with a greater emphasis on ($2+2$) and ($4+2$)

UNIT-II

Pericyclic Reactions (B)

cycloaddition-stereochemical effects and effects of substituents on the rates of cycloadditions, 1,3-dipolar cyclo-additions and cheletropic reactions. Sigmatropic Rearrangements-suprafacial and antarafacial shifts [1,2]- sigmatropic shifts involving carbon moieties retention and inversion of configuration, (3,3) and (5,5) sigma-tropic rearrangements, detailed treatment of Claisen and Cope rearrangements, fluxional tautomerism, aza-cope rearrangements, introductions to Ene reactions, simple problems on pericyclic reactions. Electrocyclic rearrangement of cyclobutenes and 1,3-cyclohexadienes.

UNIT-III

Photochemistry

Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

Determination of Reaction Mechanism

Classification, rate constants and life times of reactive energy states –determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions – photodissociation, gas-phase photolysis.

UNIT-IV

Photochemistry of Alkenes

Intramolecular reactions of the olefinic bond – geometrical isomerism, cyclisation reactions, rearrangement of 1,4- and 1, -dienes.

Photochemistry of Carbonyl Compounds

Intramolecular reactions of carbonyl compounds – saturated, cyclic and acyclic, β , γ - unsaturated and α,β -unsaturated compounds, Cyclohexadienones. Intermolecular cycloaddition reactions – dimerisations and oxetane formation.

Photochemistry of Aromatic Compounds

Isomerisations, additions and substitutions.

Miscellaneous Photochemical Reactions

Photo-Fries reactions of anilides. Photo-Fries rearrangement. Barton reaction. Singlet molecular oxygen reactions. Photochemical formation of smog. Photodegradation of polymers. Photochemistry of vision.

Books Recommended:

1. Organic Photochemistry – Chapman and Depuy.
2. Organic Photochemistry – W.H. Horspool.
3. Photochemistry of Excited States – J.D. Goyle.
4. Pericyclic Reactions: A Mechanistic study by S.M. Mukherji
5. The conservation of orbital Symmetry by R. B. Woodward and R. Hoffman
6. Fundamentals of Photochemistry by K.K. Rohtagi Mukherji

Master of Science (Chemistry)
(Semester-III)
Session: 2025-26
COURSE CODE: MCHP-3085
COURSE TITLE: Inorganic Chemistry Practical (Preparations)

Course outcomes:

Students will be able to

CO1: plan and conduct experiments for synthesizing and analysing the inorganic compounds

CO2: do measurements of magnetic moments of synthesized complexes.

CO3: estimate metal ions in the synthesized complex through various analytical techniques

CO4: interpret and characterise the metal complexes through various spectroscopic and analytical techniques

Master of Science (Chemistry)

(Semester-III)

Session: 2025-26

COURSE CODE: MCHP-3085

COURSE TITLE: Inorganic Chemistry Practical (Preparations)

Time: 6 Hrs

Max. Marks: 100

Credit (LTP): 0-0-3

(P: 70, CA: 30)

Instruction for practical examiner: Question paper is to be set on the spot jointly by the Internal and External Examiners. Two copies of the same should be submitted for the record to COE Office, Kanya Maha Vidyalaya, Jalandhar.

1. Preparation of $\text{Co}(\text{acac})_3$, its characterization using NMR, IR, UV-Vis and analysis of Cobalt. (ref. J. Chem. Edu., 1980, 57, 7,525)
2. Preparation of $\text{Co}(\text{acac-NO}_2)_3$, its characterization using NMR, IR, UV-Vis and analysis of Cobalt. (ref. J. Chem. Edu., 1980, 57, 7,525)
3. Preparation of $[\text{Fe}(\text{H}_2\text{O})_6][\text{Fe}(\text{N-salicylideneglycinato})_2]_2 \cdot 3\text{H}_2\text{O}$, its characterization using IR, UV-Vis, magnetic susceptibility and analysis of Iron. (ref. Inorganica Chimica Acta, 1977, 23,35).
4. Preparation of $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$ its characterization using IR, UV-Vis, magnetic susceptibility and analysis of Nickel and NH_3 . (ref. Marr and Rockett, 1972).
5. Preparation of $[\text{Ni}(\text{ethylenediamine})_3]\text{Cl}_2$ its characterization using IR, UV-Vis, magnetic susceptibility and analysis of Nickel. (ref. Marr and Rockett, 1972, page 270).
6. Preparation of $[\text{Fe}(\text{NO})(\text{S}_2\text{CN}(\text{Et})_2)_2]$ its characterization using IR, UV-Vis, magnetic susceptibility and analysis of Fe(II). (ref. Marr and Rockett, 1972, page 262, J. Chem. Soc. 1962, 84,3404).
7. Preparation of octahedral and tetrahedral complexes of dichlorodipyridylcobalt(II), differentiate them using IR, UV and magnetic properties. Estimate Co(II) from one of them. (ref. Marr and Rockett, 1972, page 375, Inorganic Chemistry, 1966, 5,615).
8. Preparation of $\text{VO}(\text{acac})_2$ and its piperidine complex, characterize using IR, UV and magnetic moment. Estimate for V(IV). (ref. Marr and Rockett, 1972,243).
9. Preparation of diaquotetraacetataocopper(II), magnetic susceptibility IR and UV-Vis, analysis of Copper(II).
10. Preparation of cis- and trans- potassium dioxalatodiaquochromate(III). Interpretation of IR, UV and magnetic properties. Estimation of Chromium. (ref. Marr and Rockett, 1972, page 386).
11. Preparation of $\text{HgCo}(\text{NCS})_4$, its IR and measure its magnetic moment. (ref. Marr and Rockett, 1972, page 365).

12. Preparation of sodium tetrathionate, interpretation of its IR and analysis using potassium iodate. (ref. Marr and Rockett, 1972, page214).
13. Preparation of Potassium dithionate, interpretation of its IR and analysis using potassium iodate. (ref. Marr and Rockett, 1972, page214).
14. Preparation of bis(acetylacetonato)copper(II), UV-Vis, and IR, magnetic studies, Demonstration of Jahn Teller effect by solution spectral studies. (ref. Bull. Chem. Soc. Japan, 1965, 29,852).
15. Preparation of salicylamide complexes of Copper(II). IR, UV, magnetic data and analysis of Cu(II). (ref. Indian J. of Chem., 1977, 15A, No. 5, 459; *ibid*, 1971, 9,1396).
16. To prepare a macrocyclic ligand 5,7,7,12,14,14-hexamethyl-1,4,8,11-tetraazacyclo tetradeca-4,11-dienedi(hydrogeniodide) and its complex with Ni(II). Study IR, NMR and UV-Vis of ligand and complex and magnetic properties of complex. To analyze for Ni and I. (J. Chem. Edu. 1977, 79,581).
17. Preparation and resolution of tris (ethylenediamine) cobalt (III). UV-Vis, NMR, IR, optical rotation of the resolved complexes. ((ref. Marr and Rockett, 1972, page386).

Books Recommended:

1. B.N. Figgis, Introduction to Ligand Field, WileyEastern.
2. A.B.P. Lever, Inorganic Electronic Spectroscopy, Elsevier.
3. A.Earnshaw, Introduction to Magnetochemistry, AcademicPress.
4. J.E. Huheey, Inorganic Chemistry Principles of Structure and Reactivity, Harper Interscience.
5. R.S. Drago, Physical Method in Chemistry, W.B.SaundersCompany.
6. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, WileyInterscience.
7. F.A. Cotton, Chemical Application of Group Theory, WileyEaster

Master of Science (Chemistry)
(Semester-III)
Session: 2025-26
COURSE CODE: MCHP-3086
COURSE TITLE: Physical Chemistry Practical

Course outcomes

Students will be able to

CO1: apply the principle and mechanism of Conductometric and potentiometric titrations

CO2: determine the partial molar volume of compounds using Dilatometer

CO3: determine specific and molar refractivity using Abbes refractometer

CO4: study complex formation and the kinetics of hydrolysis Spectrophotometrically

Master of Science (Chemistry)
(Semester-III)
Session: 2025-26
COURSE CODE: MCHP-3086
COURSE TITLE: Physical Chemistry Practical

Time: 6 hrs.
Credit (LTP): 0-0-3

Max. Marks: 100
(P: 70, CA: 30)

Instruction for practical examiner: Question paper is to be set on the spot jointly by the Internal and External Examiners. Two copies of the same should be submitted for the record to COE Office, Kanya Maha Vidyalaya, Jalandhar.

1. To determine the partial molar volume of
(a) Glycine (b) Urea using dilatometer
2. To determine the partial molar volume of
(a) methanol (b) n-propanol using dilatometer
3. To determine the surface tension (double capillary) of mixture of solid and water by deferential method and hence find out parachor of the mixture.
4. To determine the specific and molar refractivity of n-propanol, butanol, hexane and carbon tetrachloride and calculate refraction equivalents of C, H and Cl.
5. To determine the molar refractivity of water, DMF, Dioxane and mixtures of water-DMF, water-Dioxane and verify the refractivity rule. Predict about the interactions between components of mixture by plotting graph between refractive index and mole fraction.
6. To determine the equivalent conductance of weak electrolyte (acetic acid) at infinite dilution using Kohlrausch law.
7. Determine equivalent conductance of strong electrolyte at several concentrations and hence verify Onsager equation.
8. Determine equivalent conductance of weak electrolyte, say acetic acid at different concentrations and hence test validity of Ostwald's dilution law. Also determine dissociation constant of the electrolyte.
9. To determine dissociation constant of a dibasic acid potentiometrically.
10. To study complex formation between Fe (III) and salicylic acid and find out the formula of the complex spectrophotometrically.
11. To determine the formula of the complex ion formed between Fe (III) and thiocyanate ion by Job's method.
12. To study the kinetics of hydrolysis of crystal violet spectrophotometrically.
13. To determine the pH of various mixtures of sodium acetate and acetic acid in aqueous solution and hence determine the dissociation constant of the acid.
14. Titrate potentiometrically Zn(II) by $K_4Fe(CN)_6$ and verify the composition of the complex $K_2Zn_3[Fe(CN)_6]_2$
15. Determination of nitrite in water spectrophotometrically.
16. Determination of molecular weight of polymers by Viscometry.
17. Determine the molar refraction of a solid substance by dissolving it in a solvent and its refractive index.

Books Recommended:

1. Yadav, J. B (2005): *Advanced Practical Physical Chemistry*, 22nd edition, Goel publishing House, Krishna Prakashan Media Ltd.
2. Venkatesan, V., Veeraswamy, R. and Kulandaivelu, A.R (1997): *Basic Principles of Practical Chemistry*, 2nd edition, Sultan Chand and Sons Publication, New Delhi.

KANYA MAHA VIDYALAYA JALANDHAR (AUTONOMOUS)

**SCHEME AND CURRICULUM OF EXAMINATION OF TWO YEAR DEGREE
PROGRAMME**

Master of Science (Chemistry)

Credit Based Continuous Evaluation Grading System (CBCEGS)

(Session: 2025-26)

Semester IV

Master of Science (Chemistry) Semester IV										
Course Code	Course Title	Course Type	Hours Per Week L-T-P	Credits L-T-P	Total Credits	Marks				Examination time (in Hours)
						Total	Th	P	CA	
MCHL-4081	Advanced Inorganic Chemistry	C	4-0-0	4-0-0	4	100	70	-	30	3
MCHL-4082	Chemistry of Natural Products	C	4-0-0	4-0-0	4	100	70	-	30	3
MCHL-4083	Electrochemistry and Chemical Dynamics	C	4-0-0	4-0-0	4	100	70	-	30	3
MCHP-4084	Advanced Practical-Organic Synthesis	C	0-0-6	0-0-3	3	100	-	70	30	3*2
MCHP-4085	Advanced Practical-Inorganic Synthesis	C	0-0-6	0-0-3	3	100	-	70	30	3*2
MCHP-4086	Advanced Practical-Physical Chemistry	C	0-0-6	0-0-3	3	100	-	70	30	3*2
Total					21	600				

C- Compulsory Course

Master of Science (Chemistry)
(Semester-IV)
Session: 2025-26
COURSE CODE: MCHL-4081
COURSE TITLE: Advanced Inorganic Chemistry

Course outcome:

Students will be able to

CO1:understand Photo substitution reactions,photoredox reactions, photolysis of water

CO2:understand oxidative addition and reductive elimination, migration (Insertion) reaction and cyclometallation reactions,

CO3:characterise the compound by synthetic methods and know the chemical behaviour and synthetic applications of hydride compounds

CO4:understand hydroformylation, Carbonylation Reaction, decarbonylation reactions, hydrocyanation Polymerization, Oligomerisation and metathesis reactions

Master of Science (Chemistry)
(Semester-IV)
Session: 2025-26
COURSE CODE: MCHL-4081
COURSE TITLE: Advanced Inorganic Chemistry

Time: 3 Hrs

Max. Marks: 100

Credit (LTP): 4-0-0

(Theory: 70, CA: 30)

Note: The students are allowed to use Non-Programmable Calculator.

Instructions for the Paper Setters:

Eight questions of equal marks (16 each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from UNITs I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-I

Photo Inorganic Chemistry:

Basics of photochemistry- Absorption, excitation, photochemical laws, quantum yield, electronically excited state, energy dissipation by radiative and non-radiative processes, absorption spectra, Franck-Condon principle, photochemical stages-primary and secondary processes, Kashia's rule, Thexi state, Photo substitution reactions, Adamson's rules, Photo substitution reactions of Cr(III)-Polypyridyls, Rh(III) Ammine Complexes, Ru-Polypyridyl complexes, Ligand photo reactions, photoredox reactions, comparison of Fe(II) and Ru(II) complexes, Photo synthesis in plants and Bacterio chlorophyll photosynthesis.

UNIT-II

Oxidative-Addition and Migration (Insertion Reactions):

Introduction: Acid base behaviour of metal atoms in complexes, Protonation and Lewis Base behaviour, acceptor properties of Lewis acidity of complexes, oxidative addition and reductive elimination, addition of specific molecules, Hydrogen addition, HX additions, Organic halides addition of some other molecules productive elimination, migration (Insertion) reaction promotion of alkyl migration, insertion of CO into M-H bonds, other aspects of CO insertion reactions, transfer of other molecules, CO₂, SO₂, NO₂, RCM, Insertion of alkenes and C-C unsaturated compounds, Cleavage of C-H bonds; alkane activation, Cyclometallation reactions. Reactions of free hydrocarbons.

UNIT-III

Transition Metal Compounds with Bonds to Hydrogen

Characteristics of hydride complexes, synthetic methods, chemical behaviour of hydride compounds, mononuclear polyhydrides, homoleptic polyhydride anions; carbonyl hydrides and anion. Molecular hydrogen compounds; metal hydrogen interaction with C-H bonds; MH interactions; complexes of boron hydride and aluminohydrides, synthetic applications of metal hydrides.

UNIT-IV

Transition Metal Complexes in Catalysis:

Hydroformylation of unsaturated compounds, Reductive carbonylation of alcohols and other compounds; Carbonylation Reaction: Methanol and methyl acetate, Adipic ester. Synthesis and other carbonylation reactions, decarbonylation reactions. Cluster compounds in catalysis, supported homogeneous and phase transfer catalysis, Acrylonitrile synthesis, oxygen transfer from peroxo- and oxo- species, oxygen transfer from NO₂ groups.

Books Recommended:

1. Concepts of Inorganic Photochemistry, A. W. Adamson and P. D. Fleischauer, Wiley.
2. W.W. Porterfield, Inorganic Chemistry: A Unified Approach.
3. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 5th ed, John Wiley and Sons, New York.
4. C. Elschenbroich and A. Salzer, Organometallics: A Concise Introduction, 2nd Ed., VCH 1992.

Master of Science (Chemistry)
(Semester-IV)
Session: 2025-26
COURSE CODE: MCHL-4082
COURSE TITLE: Chemistry of Natural Products

Course outcome:

Students will be able to

CO1: study the biosynthetic pathways of natural products, understand the isoprene rule and its role in terpenoids

CO2: classify and understand the synthesis and structure of steroids and alkaloids

CO3: understand the chemistry of Haemin, chlorophyll, prostaglandins and antibiotics

CO4: classify and elucidate the structure of carbohydrates like starch and cellulose, determine the structure conformation and properties of proteins, nucleic acids, DNA and RNA

Master of Science (Chemistry)
(Semester-IV)
Session: 2025-26
COURSE CODE: MCHL-4082
COURSE TITLE: Chemistry of Natural Products

Time: 3 Hrs

Max. Marks: 100

Credit (LTP): 4-0-0

(Theory: 70, CA: 30)

Note: The students are allowed to use Non-Programmable Calculator

Instructions for the Paper Setters:

Eight questions of equal marks (16 each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from UNITs I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-1

Studies on Biosynthetic Pathways of Natural Products

The acetate hypothesis, poly-ketoacids, their aldol type cyclisations and meta orientations of hydroxyl groups in naturally occurring phenols. b) Isoprene rule, mechanism of formation of mevalonic acid from acetyl coenzyme, Biogenetic isoprene rule. Geranyl, Geranyl pyrophosphates and its conversion into thujene. Farnesyl pyrophosphate.

UNIT-II

Terpenoids

General classification, General Methods of structure determination, Chemistry of Camphor, Abietic acid, Santonin biosynthetic studies on tri and tetra terpenoids.

Steroids

General biosynthetic studies on steroids, chemistry of Cholesterol, progesterone, oestrone, transformations in steroid molecules.

Alkaloids

Classification, chemistry of nicotine and morphine.

UNIT-III

Haemin and Chlorophyll

Structure and synthesis of Porphyrins. Chemistry of Haemin and chlorophyll.

Antibiotics

Introduction, types of antibiotics, synthesis and mechanism of action of penicillins.

Prostaglandins

General study, nomenclature, structure of PGE and synthesis of PGE1, PGE2, PGF2x

UNIT-IV

Carbohydrates

Deoxy sugars, sugars, methyl others and acid derivatives of sugars. General methods of structure and ring size determination, structure of maltose, lactose, sucrose, starch and cellulose.

Peptides and Proteins

Sequence determination insulin and oxytocin, Proteins: structure conformation and properties. Enzymes, Kinetics, inhibition mechanism.

Books Recommended

1. Primary Metabolism: A Mechanistic Approach by J.Staunton, Oxford University Press 1978.
2. Secondary Metabolism by J. Mann Oxford University Press. Oxford, 1980.
3. Natural Product Chemistry- A Mechanistic, Biosynthetic and Ecological Approach by Kurt B. G. Torssell, Swadish Pharmaceutical Society, 1997.
4. Fundamentals of BioChemistry by D. Voet, J.G. Voet and C.W.Pratt, John Wiley and Sons Inc., New York, 1999.
5. Principles of Biochemistry by A.L. Lehninger, CBS Publishers, New Delhi

Master of Science (Chemistry)

(Semester-IV)

Session: 2025-26

COURSE CODE: MCHL-4083

COURSE TITLE: Electrochemistry and Chemical Dynamics

Course outcomes:

Students will be able to

CO1: Understand the electrochemistry of solutions, method of determination of electrified interfaces, semiconductor electrolyte solution interface, know theory, monitoring and prevention of corrosion

CO2: understand collision theory of reaction rates, Arrhenius theory and activated complex theory, Lindemann-Hinshelwood theory

CO3: understand various Photochemical reactions, Homogeneous catalysis and kinetics of enzyme reactions, general features and methods of studying fast reactions

CO4: interpret polarogram and applications of Voltammetry and Polarography.

Master of Science (Chemistry)
(Semester-IV)
Session: 2025-26
COURSE CODE: MCHL-4083
COURSE TITLE: Electrochemistry and Chemical Dynamics

Time: 3 Hrs

Max. Marks: 100

Credit (LTP): 4-0-0

(Theory: 70, CA: 30)

Note: The students are allowed to use Non-Programmable Calculator.

Instructions for the Paper Setters:

Eight questions of equal marks (16 each) are to be set, two in each of the four Sections (A-D). Questions of Sections A-D should be set from UNITs I-IV of the syllabus respectively. Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section.

UNIT-I

Electrochemistry Electrochemistry of solutions, Debye-Huckel-Onsager treatment and its extension, ion-solvent interactions, Debye-Huckel-Bjerrum mode, Thermodynamics of electrified interface equation, Derivation of electro-capillarity, Lipmann equation (surface excess), method of determination, structure of electrified interfaces, Guoy-Chapman, Stern models, over potential, exchange current density, derivation of Butler-Volmer equation, Tafel plot.

Semiconductor interface theory of double layer at semiconductor electrolyte solution interface, structure of double layer interfaces, effect of light at semiconductor solution interface.

Introduction to corrosion, homogeneous theory, forms of corrosion, corrosion monitoring and prevention

UNIT-II

Chemical Dynamics (A)

Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius theory and activated complex theory, ionic reactions, kinetic salt effects, treatment of unimolecular reactions, Lindemann-Hinshelwood theory. Dynamic Chain (hydrogen bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane)

UNIT-III

Chemical Dynamics (B)

Photochemical reactions between hydrogen-bromine and hydrogen-chlorine, oscillatory reactions (Belousov-Zhabotinsky reactions), Homogeneous catalysis and kinetics of enzyme reactions, general features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis.

UNIT-IV

Voltammetry and Polarography

Polarography, polarographic cells, polarogram, interpretation of polarographic waves, equation for the polarographic waves, effect of complex formation on polarographic wave, polarograms for irreversible reactions, dropping mercury electrode, current variations during life time of a drop, merits and demerits of dme, polarographic diffusion currents, Ilkovic equation, capillary characteristics, temperature, polarograms for mixture of reactants, anodic and cathodic waves, factors affecting polarographic currents, applications of polarography, treatment of data, organic and inorganic polarographic analysis, voltammetry at solid electrodes, cyclic voltammetry and interpretation of data, pilot-ion and standard addition method for quantitative analysis

Books Recommended:

1. Chemical Kinetics, K. J. Laddler, McGraw-Hill
2. Modern Electrochemistry Vol.1,2,3, J. Bochriss and A.K.N.Reddy
3. Fundamentals of electrochemistry; P.Monk
4. Principles of Instrumental Analysis; Skoog, West; Saunders Publications

Master of Science (Chemistry)
(Semester-IV)
Session: 2025-26
COURSE CODE: MCHP-4084
COURSE TITLE: Advanced Practical- Organic Synthesis

Course outcome:

Students will be able to

CO1: plan and implement advance organic synthesis and reactions

CO2: characterize organic molecules by physical and spectroscopic means, including M.P, B.P, and IR

CO3: predict the outcome and mechanism of some simple organic reactions, using a basic understanding of the relative reactivity of functional groups

Master of Science (Chemistry)
(Semester-IV)
Session: 2025-26
COURSE CODE: MCHP-4084
COURSE TITLE: Advanced Practical- Organic Synthesis

Time: 6 hrs.
Credit (LTP): 0-0-3

Max. Marks: 100
(P: 70, CA: 30)

Instruction for practical examiner: Question paper is to be set on the spot jointly by the Internal and External Examiners. Two copies of the same should be submitted for the record to COE Office, Kanya Maha Vidyalaya, Jalandhar.

1. Synthesis and Reactivity of benzalacetophenone
 - a. Bromination (Electrophilic additions) and subsequent debromination (Elimination)
 - b. Epoxidation (Cycloaddition, nucleophilic) and ring opening with hydroxide ion.
 - c. Michael addition of aniline.
 - d. Conversion of benzalacetophenone to its oxime (nucleophilic addition at C=O)
 - e. Conversion of oxime to amide (Beckmann rearrangement) and oxazole (Understand the reactivities at conjugated C=O and C=C) bond.
2. Synthesis of Cyclohexene from cyclohexanol and its conversion to 1, 2- *cis* and 1, 2- *trans* -cyclohexanediols.
 - a. Epoxidation with peracid (Cycloaddition) and *anti*- ring opening with sodium hydroxide to *cis*- cyclohexane -1, 2-diol.
 - b. Dihydroxylation with KMnO_4 (Mechanism of *syn*- and *anti*-cyclohexane-1,2-diol)
3. Preparation and characterization of the Aldol-dehydration products from various combinations of aromatic aldehydes and ketone.
Effect of substituents on aromatic aldehydes on the product distribution.
 - a. Aldehyde: benzaldehyde, 4-methylbenzaldehyde, 4-methoxybenzaldehyde.
 - b. Ketone: acetone, cyclopentanones, cyclohexanone (Book 4) 6.

Books Recommended:

1. An Introduction to Modern Experimental Organic Chemistry, R.M. Roberts, J.C. Gilbert, L.B. Rodewald and A.S. Wingrove, Holt Rinehart and Winston Inc, New York, 1969.
2. Vogel's Text Book of Practical Organic Chemistry.
3. Laboratory Experiments on Organic Chemistry, R. Edemas, J.R. Johnson and C.F. Wilcox, The Macmillan Limited, London, 1970.
4. Modern Projects and Experiments in Organic Chemistry, J.R. Mohrig, C.N. Hammonad, P.F. Schatz and T.C. Morrill, W.H. Freeman and Company, New York 2003

Master of Science (Chemistry)
(Semester-IV)
Session: 2025-26
COURSE CODE: MCHP-4085
COURSE TITLE: Advanced Practical- Inorganic Synthesis

Course outcome:

Students will be able to

CO1: apply key concepts of inorganic chemistry and coordination compounds including those related to synthesis, reaction chemistry, and structure and bonding

CO2: design the basic and advanced laboratory procedures used in inorganic synthesis

CO3: interpret and characterise the metal complexes through various spectroscopic and analytical techniques

CO4: learn separation of metal cations by chromatographic techniques

Master of Science (Chemistry)
(Semester-IV)
Session: 2025-26
COURSE CODE: MCHP-4085
COURSE TITLE: Advanced Practical- Inorganic Synthesis

Time: 6 Hrs
Credit (LTP): 0-0-3

Max. Marks: 100
(P: 70, CA: 30)

Instruction for practical examiner: Question paper is to be set on the spot jointly by the Internal and External Examiners. Two copies of the same should be submitted for the record to COE Office, Kanya Maha Vidyalaya, Jalandhar.

1. Synthesis of the Linkage Isomers nitrito- and nitropentaamminecobalt(III)chloride
 - a) Preparation of chloropentaamminecobalt(III) chloride, $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$.
 - b) Preparation of nitropentaamminecobalt(III) chloride, $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$.
 - c) Preparation of nitritopentaamminecobalt(III) chloride, $[\text{Co}(\text{NH}_3)_5(\text{ONO})]\text{Cl}_2$.
 - d) Estimate the chloride in all the complexes using gravimetric analysis.
 - e) Record and interpret the electronic absorption spectra and IR spectra of all cobalt(III) complexes and assign the observed change to distinguish the two isomers.
2. Synthesis of a coordination compound containing iron and analysis of this compound using redox methods
 - a) Preparation of iron(II) oxalate
 - b) Preparation of $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3] \cdot 3\text{H}_2\text{O}$
 - c) Characterization of Iron(II) and iron(III) complex with IR spectroscopy
 - d) Determination of iron and oxalate in $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3] \cdot 3\text{H}_2\text{O}$ using volumetric analysis
3. Synthesis and characterization of the Ni(II) complex of a Schiff-base ligand derived from Salicylaldehyde and ethylenediamine.
 - a) Synthesis of the Schiff-base ligand.
 - b) Interpret the ^1H NMR and IR spectra of the ligand.
 - c) Synthesis of the Ni(II) complex of the ligand and compare its IR spectrum with that of the ligand.
4. Separation of the metal cations by
 - a) Column chromatography with gradient elution Co(II) and Ni(II). Analyze qualitatively the coloured fractions collected for separated cations.
 - b) Paper chromatography [Fe(II), Co(II), Ni(II) and Cu(II)]. Determine the R_f values for the separate standard cations and use these to identify the cations present in the unknown mixture.

Books Recommended:

1. G. Marr, B. W. Rockett, Practical Inorganic Chemistry (1972).
2. I. Grenthe, E. Nordin, Inorganic Chemistry, 18 (1979) 1869–74.
3. J.C. Bailar, M. Eldon, *Inorg. Synth.* 1 (1939) 35–38.

Master of Science (Chemistry)
(Semester-IV)
Session: 2025-26
COURSE CODE: MCHP-4086
COURSE TITLE: Advanced Practical- Physical Chemistry

Course outcome:

Students will be able to

CO1:experience the scientific methods employed in basic and applied physical chemistry

CO2: design and perform experiments to determine the rate and order of chemical reactions by varying concentrations and/or temperature

CO3: measure equilibrium concentrations and equilibrium constants for acid-base, solubility, and complexation reactions given initial concentrations of reactant

CO4: develop skills in procedures and instrumental methods like turbidimetry and spectrophotometry.

Master of Science (Chemistry)
(Semester-IV)
Session: 2025-26
COURSE CODE: MCHP-4086
COURSE TITLE: Advanced Practical- Physical Chemistry

Time: 6 Hrs
Credit (LTP): 0-0-3

Max. Marks: 100
(P: 70, CA: 30)

Instruction for practical examiner: Question paper is to be set on the spot jointly by the Internal and External Examiners. Two copies of the same should be submitted for the record to COE Office, Kanya Maha Vidyalaya, Jalandhar.

CHEMICAL EQUILIBRIUM

1. Study the effect of solvent on the conductance of AgNO₃/Acetic acid and determine the degree of dissociation and equilibrium constant in different solvents and their mixtures (DMSO, DMF, dioxane, acetone, and water) and test the validity of DEBYE- HUCKEL-ONSAGER'S equation.
2. To determine acid and base dissociation constant of amino acid pHmetrically.
3. To calculate thermodynamic parameters for the reaction
$$\text{Zn} + \text{Hg}_2\text{SO}_4 \longrightarrow 2\text{Hg} + \text{Zn SO}_4$$
 by emf measurement.

CHEMICAL KINETICS

4. Study the salt effects and the solvent effect on the rate law of alkaline hydrolysis of crystal violet.
5. Determine the degree of hydrolysis and hydrolysis constant of CH₃COONa/NaCl/aniline hydrochloride.
6. Determine the order of reaction by analyzing the kinetic dependence of individual reactant (e.g. saponification of ester).
7. Determine the energy of activation for the reaction studied above.

ACTIVITY AND ACTIVITY COEFFICIENTS

8. Determination of mean activity coefficient of given electrolyte by cryoscopy.
9. Determine activity coefficients by EMF method.

PHASE EQUILIBRIUM

10. Draw the phase diagram for any one of the following three component partially immiscible liquid systems.
i) DMSO/water/benzene ii) water/benzene/acetic acid

SPECTROPHOTOMETRIC METHODS

11. To study the effect of extended conjugation on the wave length of maximum absorption of organic compounds.

TURBIDITYMETRY

12. To determine concentration of sulphate ions with the help of turbidity meter.
13. Determine the CMC by turbidimetric method.
14. Preparation of soap and determination of its CMC.

LEAST SQUARE FITTING

15. To draw calibration curve for the concentration determination of potassium ions by flame photometry and to study the least square fitting of the data.

POLARIMETRY

1. To find the specific rotation and molecular rotation of glucose polarimetrically and also find the concentration of unknown solution. Calculate the intrinsic rotation for glucose.
2. To find out the percentage of two optically active substances such as d-sugar and d-tartaric acid in a given solution polarimetrically.
3. To determine the specific rotation of camphor in benzene or carbon tetrachloride.

Books Recommended:

1. Yadav, J. B (2005): *Advanced Practical Physical Chemistry*, 22nd edition, Goel publishing House, Krishna Prakashan Media Ltd.
2. Venkatesan, V, Veeraswamy, R and Kulandaivelu, A.R (1997): *Basic Principles of Practical Chemistry*, 2nd edition, Sultan Chand and Sons Publication, New Delhi.
3. Findlay's (1985): *Practical Physical Chemistry*, Revised and edited by B.P. Levitt 9th edition, Longman, London.
4. Chatwal, G.R. and Anand, S.K (2000): *Instrumental Methods of Chemical Analysis*, Himalaya Publishing House, Delhi.