S.S. Jain Subodh P.G. College (Autonomous), Jaipur

MASTER OF SCIENCE
Subject : Chemistry
Semester I

Paper code	Paper Title	Type of paper	Contact Hours Per semester	Per week	Maximum marks	Minimum marks	ESE in hrs.	
							Theory	Practical
MCHE101	Inorganic chemistry	Theory	60	4	100	40	3	
MCHE102	Organic chemistry	Theory	60	4	100	40	3	
MCHE103	Physical chemistry	Theory	60	4	100	40	3	
MCHE104	Spectroscopy I	Theory	60	4	100	40	3	
MCHE105	Bioinorganic chemistry	Theory	30	2	50	20	3	
MCHE106 (a)	Mathematics for chemists	Theory	30	2	50	20	3	
MCHE 106 (b)	Biology for chemists							
MCHE151	Inorganic chemistry Practicals	Lab work	90	6	100			6
MCHE152	Physical chemistry practicals	Lab work	90	6	100			6
				32	700			

ESE = End Semester Examination

SCHEME OF EXAMINATION

(Semester Scheme)

Examination scheme

Sr. No.	Paper	ESE	CIA	Total
1.	Theory	70%	30%	100
2.	Practical	60%	40%	100

Each theory paper syllabus is divided into four units. Each theory paper 3 hours duration

Each Practical /Lab work 6 hours duration

The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for the paper concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

Note: Maximum marks for a theory paper (I-IV) is 100 marks which include 70 marks for ESE and 30 marks for internal assessment.

Maximum marks for a theory paper (V-VI) is 50 marks which include 35 marks for ESE and 15 marks for internal assessment.

Total marks for each semester practicals is 100, which include 60 marks for ESE and 40 marks for internal assessment.

MASTER OF SCIENCE

Subject : Chemistry

Semester I

Paper I-IV

Max.hrs: 3 hrs. **Max. marks: 70**

Part A- comprises of eight short answer questions with two questions from each unit (It's a compulsory question and attempt any seven) 2x7= 14marks

Part B- comprises of eight long answer questions with two questions from each unit. Candidates have to answer four questions, selecting one question from each unit. 14x4 = 56 marks

Total marks for End Semester Examination 70 marks

Internal Assessment 30 marks

Total 100 marks

Paper V-VI

Max.hrs: 3 hrs. **Max. marks : 35**

Part A- comprises of eight short answer questions with two questions from each unit. (It's a compulsory question and attempt any seven) 1x7= 7 marks

Part B- comprises of eight long answer questions with two questions from each unit.Candidates have to answer four questions, selecting one question from each unit. 7x4 = 28 marks

Total marks for End of Semester Examination 35 marks

Internal Assessment 15 marks

Total 50 marks

PAPER I Inorganic Chemistry MCHE 101 — 60 Hrs (4 hrs/week)

Unit I

Stereochemistry and bonding in main group compounds: VSEPR, Walsh Diagrams of tri atomic molecules, dπ-pπ bonds, Bent's rule and energetics of hybridization, some simple reactions of covalently bonded molecules: atomic inversion, berry pseudorotation, substitution reactions and free radical reactions.

Metal Ligand Equilibria in solution: Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH metry and spectrophotometry.

Unit II

Metal Ligand Bonding: Limitations of crystal field theory, molecular orbital theory: octahedral, tetrahedral and square planer complexes, π- bonding and molecular orbital theory.

Unit III

Electronic spectra of Transition Metal Complexes: Spectroscopic ground states, correlation, Orgel and Tanabe Sugano diagrams for transition metal complexes (d1 to d9 states) and calculation of Dq, B and β parameters.

Unit IV

Charge Transfer Spectra and magenetic properties of Transition Metal Complexes: Charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, ORD- circular dichroism (CD) and magnetic properties of transition metal complexes, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Suggested Books:

1. Advanced inorganic chemistry, F.A. Cotton and Wilkinson, John Wiley
2. Inorganic chemistry, J.E. Huheey, Harpes & Row
3. Inorganic electron spectroscopy, A.B.P. Lever, Elsevier
4. Inorganic chemistry, Shriver & Atkins, Oxford University Press
5. Mechanism of Inorganic Reaction, F.basolo and R.G. Pearson : Wiley eastern

6. Concepts and Models in inorganic chemistry, Doughlas Mc Daniel

MASTER OF SCIENCE

Subject : Chemistry

Semester I

PAPER II Organic Chemistry MCHE 102 60 Hrs (4 hrs/week)

Unit I

Reaction Mechanism: Structure and Reactivity: Types of reactions, types of mechanisms. General methods for the determination of reaction mechanism – product analysis, determination of presence of intermediates, study of catalysis, isotopic labelling, stereochemical evidences, kinetic evidences and isotope effects. Thermodyamic and kinetic requirements for a reaction, kinetic and thermodynamic control, Hammond's Postulate. Curtin-Hammett Principle, Effect of structure on reactivity, resonance and field effects, steric effects, quantitative treatments of the effect of structure on reactivity. The Hammett equation and linear free energy relationship, substituent and reaction constants, Taft equation.

Annulenes, antiaromaticity, homoaromaticity

Unit II

Aliphatic Nucleophilic Substitution*:*

S_N1, S_N2, mixed S_N1 and S_N2, ion pair and S_N1 mechanism, S_Ni mechanism, SET mechanism; neighbouring group participation and anchimeric assistance; substitution at allylic and vinylic carbon atoms; ambident nucleophiles; effects of substrate structure, attacking nucleophile, leaving group and reaction medium on reactivity; regioselectivity.

Aromatic Nucleophilic Substitution

S_NAr, S_N1, benzyne and $S_{RN}1$ mechanism; effect of substrate structure, leaving group and attacking nucleophiles on reactivity.

Unit III

Aliphatic Electrophilic Substitution: Bimolecular mechanism – S_E2 and S_Ei; the S_E1 mechanism, substitution by double bond shift; addition-elimination mechanism and cyclic mechanism; effect of substrates, leaving group and solvent polarity on the reactivity,

Aromatic Electrophilic Substitution: Arenium ion mechanism, orientation and reactivity; energy profile diagrams; directive influence and its explanation in different substitutions. o/p ratio; ipso attack, Quantitative treatment of reactivity in substrates and electrophiles.

Free radical Substitution Reactions: Detection and characteristics of free radicals; neighbouring group participation and free radical rearrangements; mechanism at an aromatic substrate, reactivity for aliphatic, aromatic substrate at bridge head carbon atom, reactivity of the attacking radical, effect of solvent.

Important reactions involving free radicals – Wohl-Ziegler bromination, autooxidation, oxidation of aldehydes to carboxylic acid, coupling of alkynes.

Unit IV

Addition to C-C and C-Hetero multiple bonds: Mechanistic and stereochemical aspects of addition reaction involving electrophiles, nucleophiles and free radical, regio and chemo selectivity, orientation and reactivity, addition to cyclopropane ring, Sharpless asymmetric epoxidation.

Wittig reaction. Mechanism of condensation reactions involving enolates – Mannich, Benzoin and Perkin reactions.

Elimination Reaction: E2, E1, $E1_CB$ and E2C (syn elimination) mechanisms; E1 – E2 – $E1_CB$ spectrum; Steric orientation of the double bond; effect of substrate structure, attacking base, leaving group and reaction medium on reactivity; mechanism and orientation in pyrolytic elimination.

Suggested Books:

1. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Jerry March, John Wiley and Sons Asia Private Limited.
2. Advanced Organic Chemistry Part A & B, Francis A. Carey and Richard J. Sundberg, Kluwer Academic/Plenum Publishers.
3. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Nelson Thornes.
4. Modern Methods of Organic Synthesis, W. Carruthers, Cambridge University Press.
5. A Guidebook to Mechanism in Organic Chemistry, Peter Sykes, Orient Longman.
6. Basic Principles of Organic Chemistry, John D. Roberts and Marjorie C. Caserio, W. A. Benzamin Inc.

MASTER OF SCIENCE

Subject : Chemistry
Semester I

PAPER III Physical Chemistry MCHE 103 60 Hrs (4 hrs/week)

Unit I

Introduction to exact quantum mechanical Results: The Schrodinger equation and the postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz., Particle in a one dimension box, three dimension box and concept of degeneracy, harmonic oscillator and the hydrogen atom including shapes of atomic orbital's .

Angular momentum

Angular momentum, Eigen functions for angular momentum, Eigen values of angular momentum, operator using ladder operators.

Unit II

Approximation methods: Approximate method of quantum mechanism. Variation theorem. Linear Variation principle, Perturbation theory (up to second order in energy), applications of variation and perturbation theory to helium atom. Chemical bonding in diatomic, Elementary concept of MO and VB theories, Huckel theory for conjugated pie electron system, bond order and charge density calculations. Application to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc.

Unit III

Chemical kinetics I: Methods of determining rate laws, Collision of transition state theory of reaction rate, steric factor, activated complex theory and Arrhenius equation, kinetic salt effects steady state kinetics, kinetic and thermodynamic control of reaction

Chemical kinetics II: Treatment of unimolecular reactions and (Lindemann, and Hinshelwood) theories of unimolecular reactions. Kinetics of enzyme reactions, homogenous catalyst, photochemical reactions (hydrogen bromine and hydrogen chloride **),** dynamic chain reaction(H-Br reaction)**,** general features of fast reaction, study of fast reaction by flow method, relaxation method**,** flash photolysis.

Unit IV

Electrochemistry;Electrochemistry of solution.Debye-Huckel-Onsager treatment and its extension . ion solvent interaction.Thermodynamics of electrified interface.determination of electrocapilary curve.Lipmann equation{surface excess].structure of electrified interface;Gouy –Chapman models,Graham Devantham,Bockris Devanathan models,Over potential,derivation of Butler Volmer equation,Tafel plot.

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Polarography theory, IIkovic equation; Half wave potential and its significance

Suggested Books:

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Introduction to Quantum Chemistry, A.K. Chandra,Tata McGraw Hill.
3. Quantum Chemistry, Ira N. Levine, Prentice Hall.
4. Chemical Kinetics, K. J. Laidler, McGraw Hill
5. Kinetics and Mechanism of Chemical Transformation, J. Rajaraman and J. Kuriacose, McMillan.
6. Modern Electrochemistry Vol.I and Vol.II J.O.M. Bockris and A.K.N. Reddy, Plenum.

MASTER OF SCIENCE
Subject : Chemistry
Semester I

PAPER IV Spectroscopy-I MCHE 104 60 hrs (4 hrs/week)

Unit I

Rotational Spectroscopy: Microwave Spectroscopy: Classification of molecules, rigid rotor model, intensity of spectral lines, selection rules, effect of isotopic substitutions, N*on rigid rotors*, Stark effect, nuclear and electron spin interaction and effect of external fields; applications.

Unit II

Vibrational Spectroscopy: Review of linear harmonic oscillator, vibrational energy of diatomic molecules, zero point energy, anharmonicity, Morse potential energy diagram, vibrational-rotational spectroscopy - P, Q, R branches, breakdown of Born – Oppenheimer approximation rules, vibration of poly atomic molecules- symmetry and fundamental vibrations, normal mode of vibrations, overtones, hot bands, fermi resonance bands.
Raman spectroscopy*:*Classical and quantum theories of Raman effect, pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, rules of mutual exclusion, coherent antistokes Raman spectroscopy CARS (brief idea).

Unit III

Electronic Spectroscopy
Atomic spectroscopy: Energy of atomic orbital, vector representation of momenta and vector coupling, spectra of hydrogen atom and alkali metal atoms.

Molecular spectroscopy: Energy levels, molecular orbitals, vibronic transitions, vibrational progression; geometry of excited states, Franck-Condon principle, electronic spectra of polyatomic molecules, emission spectra, radiation and non-radiation decay, internal conversion.

Photoelectron spectroscopy: Basic principle, ionization process, Koopman's theorem, photoelectron spectra of simple molecules, ESCA, chemical information from ESCA, Auger electron spectroscopy (basic idea).

Unit IV

ESR and Mossbauer Spectroscopy

Electron spin resonance spectroscopy: Hyperfine coupling, spin polarization for atoms and transition metal ions, spin orbit coupling and significance of g-tensors, application to transition metal complexes (having one unpaired electron) including biological systems and to inorganic free radicals such as PH_4, F_2^- and $[BH_3]^-$.
Mossbauer spectroscopy: Basic principles, spectral parameters and spectrum display, application of (I) bonding and structure of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin, (II) Sn^{2+} and Sn^{4+} compounds nature of M-L bond, co-ordination number, structure. (III) detection of oxidation state and inequivalent MB atoms.

Suggested Books:

1.Modern Spectroscopy, J.M. Hollas, John wiley
2. Physical Methods in chemistry, R.S. Drago, Saunders college
3.Applied electron spectroscopy for chemical analysis, D.H. Windawi and F.L. Ho, Wiley interscience
4.NMR, NQR, EPR and Massbauer spectroscopy in inorganic chemistry, R.V. Parish, Ellis harwood
5.Introduction to Molecular spectroscopy, G.M. arrow, McGraw Hill Fundamentals of Molecular Spectroscopy, Third Edition; Colin N, Banwell and Elaine M, Mc Cash; Tata McGraw Hill, New Delhi, 1983.

MASTER OF SCIENCE

Subject : Chemistry
Semester I

PAPER V : Bioinorganic Chemistry MCHE 105 30 hrs (2 hrs/week)

Unit I

Metals in life processes: Role of metal ions in biological systems; essential and non- essential elements- macro minerals and essential trace elements- synergism and antagonism among essential trace element ; active transport of Na, K, Mg and Ca ions across the biological membrane; Na^+/K^+ pump, elements of bioenergetics with special reference to elements of high energy phosphate bond.

Unit II

Electron Carriers and Photosynthesis: Electron transfer in biology : structure and functions of electron transfer proteins. Cytochromes and respiratory chain, iron-sulphur proteins rubredoxin and ferridoxins. Synthetic models for Fe_4S_4 cluster only.

Photosynthetic pigments: Photochemistry of chlorophyll molecules, mechanism of photosynthesis. Calvin cycle and quantum efficiency. Function of photosystem – I and Photosystem- II. Cyclic and non-cyclic photophosphorylation.

Unit III

Transport and Storage of Dioxygen: Heam proteins and oxygen uptake. Structure and function of haemoglobin, myoglobin. Structural model for dioxygen binding co-operativity. Perutz mechanism and bohr effect ; non-haem oxygen carriers in some lower animals, haemocyanin and haemerythrin. Model synthetic complexes of iron, cobalt and copper.

Unit IV

Nitrogen fixation: Nitrogen in biosphere, nitrogen cycle, nitrification role microorganism, nitrogen fixation in soils, biological nitrogen fixation and its mechanism, nitrogenase, chemical nitrogen fixation and other nitrogenase model systems.

Suggested Books:

1. Principles of Bioinorganic chemistry, S.J. Lippard and J.M.B. University science books
2. Bioinorganic chemistry, I.Bertini, H.B.gray, S.J. Lippard, J.S. valentine, University science books
3. Inorganic biochemistry, vols. I and II, ed. G.L. Eichhorn, Elsevier
4. Progress in Inorganic chemistry, vols 18 and 38 ed. J.J. Lippard, wiley

MASTER OF SCIENCE
Subject : Chemistry
Semester I

PAPER VI Mathematics for Chemists MCHE 106(a) 30 hrs (2 hrs/week)
(For students without Maths in B.Sc.)

Unit I

Matrix Algebra: Matrix addition and multiplication, inverse, adjoint and transpose of matrices, special matrices (symmetric, skew-symmetric, Hermitian, skew- Hermitian, Unit, diagonal, Unitary etc.) and their properties, Matrix equations: homogeneous, non-homogeneous, linear equations and conditions for the solution, linear dependence and independence. Introduction to vector spaces, matrix eigen values and eigen vectors, diagonalisation, determinants (examples from Huckel theory)

Unit II

Differential Calculus: Functions, continuity and differentiability, Rules for differentiation, applications of differential calculus including maxima and minima (examples related to maximally populated rotational energy levels, Bohr's radius and most probable velocity from Maxwell's distribution etc.).

Unit III

Integral calculus: Basic rules for integration, integration by substitution, integration by parts and through partial fraction, reduction formula, applications of integral calculus.
Functions of several variables, partial differentiation, co-ordinate transformation (example Cartesian to spherical polar)

Unit IV

Elementary Differential Equations: First order and first degree differential equations, homogenous, exact and linear equations; applications to chemical kinetics, secular equilibria, quantum chemistry etc. Second order differential equations and their solutions.

Vectors: Vectors, dot, cross and triple products etc., operators – gradient, divergence and curl. Vector calculus.

Suggested Books:

1. The chemistry mathematics book, E.Steiner, Oxford university press
2. Mathematics for chemistry, Doggett and Suicliffe, Longman
3. Mathematical preparation for physical chemistry, F. Daniels, Mcgraw Hill
4. Chemical Mathematics, D.M. Hirest, Longman
5. Applied Mathematics for physical chemistry, J.R. Barante, Prentice hall
6. Basic Mathematics for chemist, Tebbutt, wiley

MASTER OF SCIENCE
Subject : Chemistry
Semester I

PAPER VI Biology for Chemists **MCHE 106(b)** **30 hrs (2 hrs/week)**
(For students without Biology in B.Sc.)

Unit I

Cell structure and Functions: Structure- prokaryotic and eukaryotic cells, intracellular organelles and their functions, comparison of plants and animal cells. Overview of metabolic process- catabolism and anabolism. ATP- the biological energy currency. Origin of life, unique properties of carbon, chemical evolution, and rise of living systems, Intoduction to biomolecules, building blocks of bio-macromolecules.

Unit II

Carbohydrates: Conformations of monosaccharides, structure and functions of important derivatives of monosaccharides likeglycoside, deoxy sugars, myoinositol, aminosugars, N-acetylmuramic acid, sialic acid, disaccharides and polysaccharides. Structural polysaccharides – cellulose and chitin. Storage polysaccharides – starch anf glycogen. Structural and biological function of glucosaminoglycans or mucopolysaccharides, Carbohydrates of glycoproteins and glycolipids. Role of sugars in biological recognition. Blood group substances. Ascorbic acid.

Carbohydrate metabolism- Kreb's cycle, glycolysis, glycogenesis, and glycogenolysis, gluconeogenesis, pentose phosphate pathway.

Unit III

Lipids: Fatty acids, essential fatty acids, structure and functions of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Lipoproteins- composition and function, role in atherosclerosis.

Properties of lipid aggregates – micelles, bilayers, liposomes and their possible biological functions. Biological membranes. Fluid mosaic model of membrane structure**,** Lipid metabolism – β – oxidation of fatty acids.

Unit IV

Proteins: Structure of proteins - α helix and β sheets, super secondary structure. Triple helix structure of collagen. Tertiary structure of protein – folding and domain structure. Quarternary structure of proteins.

Nucleic Acids: Purines and pyrimidine bases of nucleic acids, base pairing via hydrogen bonding. Structure of RNA and DNA, double helical structure of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis of heredity, an overview of replication of DNA, transcription, translation and genetic code, chemical synthesis of mono and tri-nucleosides.

Suggested Books:

1. Principles of Biochemistry, A.L.Lehninger, Worth publishers.
2. Biochemistry, Voet and Voet, John Wiley.
3. Biochemistry L.Stryer W.H. Freeman.
4. Outlines of biochemistry E.E.Conn and P.K. Stumpf, John Wiley

MASTER OF SCIENCE

Subject : Chemistry

Semester I

Practicals

Note: Total marks for each semester practicals is 100, which include 60 marks for ESE and 40 marks for internal assessment.

Semester I

Duration 6 hours Max. Marks: 60

MCHE 151 Inorganic Chemistry

a) Analysis of mixture containing eight radicals including one rare element 24 marks

b) Preparation of one selected inorganic compound and its study by IR

or

Chromatographic separation of two metal ions by TLC and determination of their Rf values 16 marks

Record 10 marks

Viva 10 marks

Duration 6 hours Max. Marks: 60

MCHE 152 Physical Chemistry

Two physical experiments from the prescribed syllabus of 20 marks each 20x2 = 40 marks

Record 10 marks

Viva 10 marks

Inorganic Chemistry Practical MCHE 151 90 hrs (6hrs/week)

Qualitative Analysis :- Qualitative analysis of Inorganic mixture for 8 radicals

(a) Less common metal ions- Tl, Mo, W,Ti, Zr, Th, V, U (two metal ions in cationic/anionic forms)
(b) Insolubles- oxides, sulphates and halides
(c) Interfering radicals- Oxalate, fluoride, borate

Preparations:

Preparation of selected inorganic compounds and their study by IR spectra, ESR and magnetic susceptibility measurement.

1. $K_3[Fe(C_2O_4)_3]$
2. $[Ni(NH_3)_6]Cl_2$
3. $[Ni(DMG)_2]$
4. $[Cu(NH_3)_4]SO_4$
5. Prussian blue
6. $[Co(NH_3)_6]$ $[Co(NO_2)_6]$

Chromatographic separation:- Thin layer chromatography separation of Nickel, Manganese, Cobalt and zinc, determination of Rf values.

MASTER OF SCIENCE

Subject : Chemistry
Semester I

Physical Chemistry Practical **MCHE 152** **90 hrs (6hrs/week)**

ERROR ANALYSIS AND STATISTICAL DATA ANALYSIS

Errors, types of errors, minimization of errors distribution curve, precision accuracy and combination; statistical treatment for error analysis, student 't' test, null hypothesis rejection criteria. F and Q test; linear regression analysis, curve fitting. Calibration of volumetric apparatus, burette, pipette and standard flask.

SERIES OF EXPERIMENTS ON CONDUCTIVITY

1. Determination of solubility and solubility product of sparingly soluble salts (e.g. $PbSO_4$,$BaSO_4$) conductor electrically.
2. Determination of the strength of strong and weak acids in a given mixture conductometrically.
3. To determine the equivalent conductance of a strong electrolyte at several concentration and hence verify the Onsager equation and also find value of a and b in this equation
   i. $\lambda_c = \lambda° - (a\lambda° + b)\sqrt{c}$
4. To determine the equivalent conductivity of an electrolyte at infinite dilution. Determine the dissociation constant of an acid at different dilutions.

SERIES OF EXPERIMENTS ON PHASE EQUILIBRIA-:

1. Determination of congruent composition and temperature of a binary system (e.g.,diphenylamine-benzophenone system)
2. To construct the phase diagram for three component system (e.g. chloroform-acetic acid, water).

SERIES OF EXPERIMENTS ON SPECTROPHOTOMETRY

1. Verify Beer`s law for the solution of potassium permanganate and determine the concentration of the given aqueous solution of unknown concentration of this salt.
2. Determine the pH of the solution employing methyl red indicator spectrophotometrically.
3. Determine indicator constant pKa of methyl red spectrophotometrically

Suggested Books:

1. Vogel's Textbook of Quantitative Chemical Analysis; Fifth Edition; G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney; Longman Scientific and Technical Publication, England, 1991.
2. Vogel's Qualitative Inorganic Analysis, Sixth Edition; G. Svehla; Orient Longman, New Delhi, 1987.
3. Advanced Practical Physical Chemistry; Twenty-second Edition; J.B.Yadav; Goel Publishing House, Merrut,2005.
4. Infrared and Raman Spectra; Inorganic and co-ordination Compounds, Fifth Edition Part A & B; K.Nakamoto; John Wiley and Sons, Inc., New York, 1997.

MASTER OF SCIENCE
Subject : Chemistry
Semester II

Paper code	Paper Title	Type of paper	Contact Hours Per semester Per week		Maximum marks	Minimum marks	ESE in hrs.	
							Theory	practical
MCHE201	Inorganic chemistry	Theory	60	4	100	40	3	
MCHE202	Organic chemistry	Theory	60	4	100	40	3	
MCHE203	Physical chemistry	Theory	60	4	100	40	3	
MCHE204	Spectroscopy II	Theory	60	4	100	40	3	
MCHE205	Biophysical chemistry	Theory	30	2	50	20	3	
MCHE206	Environmental Chemistry-I	Theory	30	2	50	20	3	
MCHE251	Organic chemistry Practicals	Lab work	90	6	100			6
MCHE252	Physical chemistry practicals	Lab work	90	6	100			6
				32	700			

ESE = End Semester Examination

SCHEME OF EXAMINATION
(Semester Scheme)

Examination scheme

Sr. No.	Paper	ESE	CIA	Total
1.	Theory	70%	30%	100
2.	Practical	60%	40%	100

Each theory paper syllabus is divided into four units. Each theory paper 3 hours duration

Each Practical /Lab work 6 hours duration

The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for the paper concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

Note: Maximum marks for a theory paper (I-IV) is 100 marks which include 70 marks for ESE and 30 marks for internal assessment.
Maximum marks for a theory paper (V-VI) is 50 marks which include 35 marks for ESE and 15 marks for internal assessment.
Total marks for each semester practicals is 100, which include 60 marks for ESE and 40 marks for internal assessment.

MASTER OF SCIENCE
Subject : Chemistry
Semester II
Paper I-IV

Max.hrs: 3 hrs. **Max. marks : 70**

Part A- comprises of eight short answer questions with two questions from each unit.. (It's a compulsory question and attempt any seven) 2x7= 14marks

Part B- comprises of eight long answer questions with two questions from each unit. Candidates have to answer four questions, selecting one question from each unit. 14x4 = 56 marks

Total marks for End of Semester Examination 70 marks

Internal Assessment 30 marks

Total 100 marks

Paper V-VI

Max.hrs: 3 hrs. **Max. marks : 35**

Part A- comprises of eight short answer questions with two questions from each unit. (It's a compulsory question and attempt any seven) 1x7= 7marks

Part B- comprises of eight long answer questions with two questions from each unit.Candidates have to answer four questions, selecting one question from each unit. 7x4 = 28 marks

Total marks for End Semester Examination 35 marks

Internal Assessment 15 marks

Total 50 marks

Semester II

PAPER I Inorganic Chemistry MCHE 201 60 Hrs (4 hrs/week)

Unit I

Symmetry and Group theory in Chemistry: Symmetry elements and symmetry operation, definition of group, subgroup, conjugacy relation and classes. Point symmetry group. Schnofilies symbols, representations of groups by matrices (representations for the Cnh , Cnv etc. group to be worked on explicitly). Character of representation. The great orthogonality theorem (without proof) and its importance. Character tables and their use, spectroscopy. Derivation of character table for C2v and C3v point group. Symmetry aspects of molecular vibrations of water molecule.

Unit II

Reaction mechanism of Transitions metal complexes: Energy profile of a reaction (transition state or activated complex) nucleophilic and electrophilic substitution, factors responsible for including SN1 and SN2 reaction, Lability and inertness of octahedral complexes according to VBT and CFT.

Electron Transfer Reactions: Outer sphere reaction and inner sphere reaction. Mechanism of one electron transfer reaction and two electron transfer reaction. Synthesis of coordination compounds using electron transfer reactions, mixed valance complexes and internal electron transfer.

Unit III

Metal π-complexes: carbonyls and nitrosyls: Metal carbonyls: Preparation, structure and bonding in metal carbonyls, vibrational spectra of metal carbonyls for bonding and structural elucidation.

Metal nitrosyls: Preparation, bonding, structure and important reactions of transition metal nitrosyl.

Unit IV

Solid state Chemistry:

Crystal defects and Non-Stoichiometry

Perfect and imperfect crystals, intrinsic and extrinsic defects, point defects , line and plane defects, vacancies- schottky defects and frenkel defects. Thermodynamics of Schottky and frenkel defect formation, colour centres, non-stoichiometry and defects.

Solid state reactions:

Introduction to the solid state, electrical, optical, magnetic and thermal properties of inorganic materials.

Organic solids:

Electrically conducting solids, organic charge transfer complex, organic metals, new superconductors

Books suggested:

1. Advanced inorganic chemistry, F.A. Cotton and Wilkinson, john wiley
2. Inorganic chemistry, J.E. Huhey, Harpes & Row
3. Inorganic chemistry, Shriver & Atkins, Oxford university press
4. Mechanism of Inorganic Reaction, F.Basolo and R.G. Pearson : wiley eastern
5. Concepts and Models in inorganic chemistry, Doughlas Mc Daniel
6. Principles of solid State, H.V. Keer; Wiley Eastern.
7. Quantum Chemistry; Fourth Edition; Ira N. Levine; Prentice-Hall of India Pvt. Ltd, New Delhi, 2002.
8. Introductory Quantum Chemistry; Fourth Edition; A.K. Chandra; Tata McGraw Hill Publishing Company, New Delhi, 1998.
9. Quantum Chemistry; Second Edition; R.K. Prasad; New Age International (P) Ltd, New Delhi, 2003.

MASTER OF SCIENCE

Subject : Chemistry

Semester II

PAPER II Organic Chemistry MCHE 202 60 Hrs (4 hrs/week)

Unit I

Stereochemistry: Optical isomerism, elements of symmetry chirality, enantiomers, diastereomers, molecules with more than one chiral center. DL, RS, EZ nomenclature in cyclic systems, absolute configuration, optical purity resolution, prochirality; enantiotopic and diastereotopic atoms, groups and faces.

Pseudoasymmetry: Optical activity in the absence of chiral carbons (biphenyls, allenes, spiranes), chirality due to helical shape; chirality in the compounds containing N, S and P.

Geometrical isomerism in cyclic and condensed systems (decalins, decalols and decalones), conformational analysis of cycloalkanes (5, 6, 7 membered rings) and decalins, effect of conformation on reactivity. Asymmetric synthesis, Cram's rule, Prelog's rule, Circular birefringence. CD, ORD, octant rule, Cotton effect. The Axial haloketone rule. Determination of absolute and relative configuration and conformation.

Unit II

Reagents and Methods in Organic Synthesis: Principle, preparations, properties and applications of the following in organic synthesis with mechanistic details:

Phase transfer catalysts, Crown ethers and cryptands. Merrifield resins, DCC (Dicyclohexylcarbodiimide), Wilkinson's catalyst, Tributyl tin hydride, Selenium dioxide, DDQ (2,3-Dichloro-5,6-dicyano-1,4-benzoquinone), 1,3-Dithiane, Thallium nitrate, Peterson synthesis, Suzuki coupling, Negishi coupling, Heck Reaction.

Unit III

Molecular Rearrangements: General mechanistic consideration – nature of migration, migratory aptitudes, memory effects. A detailed study of the following rearrangements:

Pinacol-pinacolone rearrangement, Wagner-Meerwein rearrangement, Demjanov rearrangement, Benzil-benzilic acid rearrangement, Favorskii rearrangement, Arndt-Eistert rearrangement, Neber rearrangement, Beckmann rearrangement, Hofmann rearrangement, Curtius rearrangement, Lossen rearrangement, Schmidt rearrangement, Wolff rearrangement, Baeyer-Villiger oxidation, Shapiro reaction, Dienone- phenol rearrangement, Wittig rearrangement, Stevens rearrangement.

Unit IV

Pericyclic Reactions

General characteristics, classification, molecular orbital symmetry.

Electrocyclic reactions: Theories of explanation (FMO, Woodword-Hoffmann and PMO approach), frontier orbitals of ethylene, 1, 3-butadiene, 1, 3, 5-hexatriene and allyl systems, conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems.

Cycloaddtion Reactions: 2+2, 4+2 cycloaddition, 1, 3-dipolar cycloaddition and cheletropic reactions; stereoselectivity (endo, exo), stereospecific and regioselective hydrogen reactions, Lewis-acid catalysis in Diels' Alder reaction.

Sigmatropic rearrangements: Suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties, 3, 3- and 5, 5-sigmatropic rearrangements; Claisen, Cope and Aza-Cope rearrangements; isomerization of divinyl cyclopropane; fluxional tautomerism (bullvalene); ene reaction.

Suggested Books*:*

1. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Jerry March, John Wiley and Sons Asia Private Limited.
2. Advanced Organic Chemistry Part A & B, Francis A. Carey and Richard J. Sundberg, Kluwer Academic/Plenum Publishers.
3. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon; Nelson Thornes.
4. Modern Methods of Organic Synthesis, W. Carruthers; Cambridge University Press.
5. A Guidebook to Mechanism in Organic Chemistry, Peter Sykes, Orient Longman.
6. Basic Principles of Organic Chemistry, John D. Roberts and Marjorie C. Caserio, W. A. Benzamin Inc.

MASTER OF SCIENCE
Subject : Chemistry
Semester II

PAPER III Physical Chemistry MCHE 203 60 Hrs (4 hrs/week)

UNIT I

Classical Thermodynamics I: Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar properties; partial molar free energy, partial molar volume and partial molar heat content and their significances. Determination of these quantities. Concept of fugacity and determination of fugacity.

Non-ideal systems: Excess functions for non ideal solutions. Activity, activity coefficient, Debye Huckel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficient; ionic strength.

Application of phase rule to three component system; second order phase transition.

UNIT II

Statistical Thermodynamics II: Concepts of phase space, microstate and macrostate, ensemble, postulate of ensemble averaging canonical, grandcanonical and microcanonical ensembles, Maxwell-Boltzmann distribution law using Lagrange's method of undetermined multipliers. Bose-Einstein statistics,(distribution lawand application to helium) Fermi-Dirac statistics(distribution law and application to metal), Maxwell-Boltzman statistics, comparison of three statistics. Partition functions – translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions- Energy, specific heat at constant volume and constant pressure, entropy, work function, pressure, Gibb's free energy and chemical potential. Chemical equilibria and equilibrium constant in terms of partition functions.

UNIT III

Surface chemistry: Surface chemistry;- Surface tension, capillary action ,pressure difference across curved surface (laplace equation), vapour pressure of droplets(Kelvin equation) Gibbs adsorption isotherm, estimation of surface area (BET equation) ,surface films on liquids (electro kinetic phenomeneon)

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

UNIT IV

Solid State and polymer chemistry: General principles experimental procedure, co precipitation as a cursor to solid state reactions, kinetics of solid state reactions Crystal structures, Bragg's law and applications ,band structure of solids. Molar masses. Molecular mass, number and mass average molecular mass ,molecular mass determination (osmometry, viscometry,diffusion and light scattering methods), sedimentation, chain configuration of macromolecules, calculation of average dimension of various chain structures**.**

Suggested Books

1. An Introduction to Chemical Thermodynamics, Sixth Revised Edition; R.P Rastogi and R.R Misra; Vikas publishing, Pvt Ltd. New Delhi, 1995.
2. Thermodynamics For Students Of Chemistry, Second Edition; K.Rajaram and J.C Kuriacose; S.L.N Chand and Company, Jalandhar.
3. Statistical thermodynamics, Second Edition; M.C Gupta; New Age International Pvt Ltd., New Delhi, 1995.
4. Physical Chemistry, A Molecular Approach, First Edition; D.A. Mc Qurrie and J.D Simon; Viva Low Priced Student Edition, New Delhi, 1998.
5. Thermodynamics for Chemists, Third Edition; Samuel Glasston; Affiliated East -West Press Pvt. Ltd., New Delhi, 1999.
6. Physical Chemistry, P.W. Atkins, ELBS.
7. Coulson's Valence, R. Mc Weeny, ELBS.
8. Micelles,Theoretical and Applied Aspects, V.Moroi, Plenum.
9. Introduction to Polymer Science,V.R.Gowarikar, N.V.Vishwanathan and J.Sridhar, Wiley Eastern.

MASTER OF SCIENCE

Subject : Chemistry
Semester II

PAPER IV Spectroscopy II MCHE 204 60 Hrs (4 hrs/week)

UNIT I

UV and Visible Spectroscopy

Various electronic transitions (185-800nm), Beer- Lamberts law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polymers. Woodward-Fieser rule for conjugated dienes, α,β-unsaturated carbonyl compounds. Ultraviolet spectra of aromatic compounds. Steric effects in biphenyls.

UNIT II

IR Spectroscopy

Quantitative studies: Calculation of force constants, factors effecting the shift in group frequencies – isotope effect, hydrogen bonding, solvent effect, electronic effects (inductive and mesomeric) and steric effect; different absorption regions in IR spectra.

Characteristics functional group absorptions in organic compounds: Carbon skeletal vibrations (alkanes, alkenes, alkynes, aromatic compounds), alcohols, phenols, ethers, ketones, aldehydes, carboxylic acids, amides, acid anhydrides, conjugated carbonyl compounds, esters, lactones, lactums, amines, amino acids; interpretation of IR spectra of typical organic compounds. Overtones, combination bands and fermi-resonance.

UNIT III

Proton magnetic resonance spectroscopy: General introduction, chemical shift and factors affecting chemical shift, spin-spin interaction, factors affecting coupling constant, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides and mercaptides), chemical exchange, effect of deuteration, complex spin-spin interaction between two, three, four, and five nuclei (first order spectra), stereochemistry, hindered rotation, Karplus curve variation of coupling constant with dihedral angle, simplification of complex spectra – nuclear magnetic double resonance, NMR shift reagents. Solvent effects, Fourier transform technique and its advantages, nuclear overhauser effect (NOE).

^{13}C NMR spectroscopy: General considerations, chemical shift, (aliphatic, olefinic, alkyne, aromatic, heteroaromatic & carbonyl carbon), coupling constant. Two dimensional NMR spectroscopy – COSY, NOESY, DEPT, INEPT, APT and INADEQUATE techniques.

NMR spectra of nuclei other than ^{1}H and ^{13}C: ^{19}F, ^{31}P and ^{11}B.

UNIT IV

Mass Spectrometry: Introduction, ion-production—EI, CI, FD and FAB, factors influencing fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement, Nitrogen rule. High resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with repect to their structure determination.

Suggested Books

1. Spectrometric Identification of Organic Compounds, R.M. Silverstein and F.X. Webster; John Wiley and Sons.
2. Applications of Spectroscopy, William Kemp; Palgrave Publisher Ltd.
3. Applications of Absorption Spectroscopy of Organic Compounds, J.R. Dyer, Prentice-Hall of India Pvt. Ltd.
4. Spectroscopic Methods in Organic Chemistry, Dudley H. Williams and Ian Fleming; Tata McGraw Hill Publishing Company Ltd.
5. Spectral Analysis of Organic Compounds, Creswell and Campbell, Longman.

MASTER OF SCIENCE
Subject : Chemistry
Semester II

PAPER V Biophysical Chemistry MCHE 205 30 Hrs (2 hrs/week)

Unit I

Bioenergetics

Standard free energy change in biochemical reactions, exergonic , endergonic , hydrolysis of ATP, synthesis of ATP from ADP, muscular contraction and energy generation in mechanochemical system.

Unit II

Biopolymer Interactions

Forces involved in biopolymer interactions. Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions. Multiple equilibria and various types of binding processes in biological systems. Hydrogen ion titration curves.

Unit III

Cell membrane and transport of ions

Structure and function of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport, nerve conduction. Domain membrane equilibrium. Active transport mechanism, autoanalysers, its parts and functioning. Radioisotopes, Units, specification, dilution factor, percentage incorporation, measurements.

Unit IV

Biopolymers and their molecular weights

Evaluation of size, shape, molecular weight and extent of hydration of biopolymers by various experimental techniques. Sedimentation equilibrium, hydrodynamic methods, diffusion, sedimentation velocity, viscosity, electrophoresis and rotational motions.

Suggested books:

1. Biophysical Chemistry, Vol,. I-III, Twelth Edition; Cantor, C.R. & Schimmel, Paul R.; W.H. Freeman & Company, U.S.A., 2002
2. Principles of Biochemistry, Third Edition; Lehninger, A. L., Nelson, D.L. & Cox, M. M. Lehninger; McMillan Press Ltd., London, 2002.
3. Outlines of Biochemistry, E.E.Conn and P.K. Stumpf, John wiley.
4. Biochemistry, voet and voet, john wiley.
5. Biochemistry, J.David Rawn, Neil Patterson.

MASTER OF SCIENCE
Subject : Chemistry
Semester II

PAPER VI Environmental Chemistry - I MCHE 206 30 Hrs (2 hrs/week)

UNIT I

Atmospheric Chemistry

Atmospheric layers, Vertical temperature profile, heat/radiation budget of the earth atmosphere systems. Properties of troposphere, thermodynamic derivation of lapes rate. Temperature inversion. Calculation of Global mean temperature of the atmosphere pressure variation in atmosphere and scale height. Biogeochemical cycles of carbon,nitrogen, sulphur, phosphours,oxygen. Residence times, Sources of trace atmospheric constituents : nitrogen oxides, sulphur dioxide and other sulphur compounds,carbon oxides chlorofluorocarbons and other halogen compounds, methane and other hydrocarbons.

UNIT II

Tropospheric Photochemistry

Mechanism of photochemistry decomposition of NO_2 and formation of ozone . Formation of oxygen atoms .hydroxyl, hydroperoxy and organic radicals and hydrogen peroxide. Reaction of OH radicals with SO_2 and NO_2. Formation of Niitrate radical and its reactions Photochemical smog, metrological conditions and chemistry of its formation.

UNIT-III

Air Pollution

Air pollutants and their classifications. Aerosols-sources, size distribution and effect on visibility, climate and health.

Acid Rain

Definition Acid rain precursors and their aqueous and gas phase atmospheric oxidation reactions. Damaging effects on aquatic life, plants, buildings and health. Monitoring of SO_2 and NOx and acid rain control strategies.

Stratospheric Ozone Depletion

Mechanism of ozone formation, Mechanism of catalytic ozone deletion, discovery of Antarctic ozone hole and role of chemistry and meteorology, control Strategies.

Green House Effect

Terrestrial and solar radiation spectra, major green house gases and their sources and global warming potentials. Climate change and consequences.

Urban Air Pollution

Exhaust emissions, damaging effects of carbon monoxide, monitoring of CO,control strategies.

UNIT IV

Aquatic Chemistry and Water pollution

Redox chemistry in natural waters. Dissolved oxygen, biological oxygen demand, chemical oxygen demand, determination of DO and BOD and COD. Aerobic and anaerobic reactions of organic sulphur and nitrogen compounds in water, acid- base chemistry of fresh water and sea water. Aluminium, nitrate and fluoride in water, petrifaction, sources of water pollution, treatment of waste and sewage. Purification of drinking water, techniques of purification and disinfection

Suggested Books:

1. Environmental Chemistry, Colin Baird, W.H.Freeman Co. New York,1998
2. Chemistry of Atmospheres, R.P. Wayne, Oxford.
3. Environment Chemistry, A.K. De Wiley Eastern,2004
4. Environmental Chemistry, S.E. Manahan, Lewis Publishers.
5. Introduction to Atmospheric Chemistry, P.V.Hobbs,Cambridge.
6. Chemistry of the Environment, Thomas G. Spiro, William M. Stigliani
7. Environmental Chemistry, B.K. Sharma

MASTER OF SCIENCE
Subject : Chemistry
Semester II
Practicals

Note: Total marks for each semester practicals is 100, which include 60 marks for ESE and 40 marks for internal assessment.

Semester II

Duration 6 hours Max. Marks: 60

MCHE 251 Organic Chemistry

a) Quantitaive Analysis from the prescribed syllabus 25 marks
b) Preparation of one selected organic compound 15 marks
Record 10 marks
Viva 10 marks

Duration 6 hours Max. Marks: 60

MCHE 252 Physical Chemistry

Two physical experiments from the prescribed syllabus of 20 marks each 20x2 =40 marks
Record 10 marks
Viva 10 marks

Organic Chemistry Practical MCHE251 90 hrs (6 hrs/week)

Synthesis

One and Two step synthesis

i) Coupling reaction (phenylazo-β-naphthol from aniline)
ii) Aldol condensation (dibenzal acetone from benzaldehyde)
iii) Oxidation (Cyclohexanol/ cyclohexene to adipic acid by chromic acid oxidation)
iv) Aniline → 2,4,6-tribromoaniline → 1,3,5-tribromobenzene
v) Aniline →Diazoaminobenzene → p-aminoazobenzene
vi) Nitrobenzene → m-dinitrobenzene → m-nitroaniline
vii) Acetanilide → p-nitroacetanilide → p-nitroaniline
viii) Acetanilide → p-bromoacetanilide → p-bromoaniline
ix) Resorcinol → flouroscein → Eosin
x) Phthalic anhydride → phthalimide → anthranilic acid

Quantitative analysis

i. Determination of the percentage and number of hydroxyl groups in an organic compound by acetylation method.
ii. Estimation of amines/phenols using bromate bromide solution
iii. Determination of iodine and saponification value of an oil sample
iv. Determination of neutralization equivalent of the acid.
v. Estimation of sulphur by messenger or fusion method.
vi. Estimation of halogen by fusion or stepnow's method.
vii. Estimation of nitrogen by kjeldahl's method.

MASTER OF SCIENCE
Subject : Chemistry
Semester II

Physical Chemistry Practical MCHE252 90 hrs (6 hrs/week)

SERIES OF EXPERIMENTS ON CHEMICAL KINETICS

1. Study the kinetics of the reaction between $K_2S_2O_8$ (potassium persulphate) and KI (potassium iodide) and determine the rate constant and the energy of activation of the reaction.
2. Determination of the rate constants for the oxidation of iodide ion by peroxide studying the kinetics as an iodine clock reaction
3. Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodide ion is oxidized by persulphate ion) Determine the order with respect to Ag(I) in the oxidation of Mn(II) by $S_2O_8^{2-}$ and the rate constant for the uncatalyzed reaction.
4. Determine the energy of activation and entropy of activation for the reaction.
   $2MnO_4^- + 5C_6H_5CH_2OH + 6\,H^+ \rightarrow 2Mn^{2+} + 5C_6H_5CHO + 8H_2O$

SERIES OF EXPERIMENTS ON POTENTIOMETRY / PH METRY

1. Determination of strength of halides in a mixture potentiometrically.
2. Determination of strength of strong and weak acids in a given mixture using a potentiometer / Ph meter.
3. Determination of temperature dependence of EMF of a cell.
4. Determination of formation constant of silver – ammonia complex and stoichiometry of the complex potentiometrically.
5. Determination of activity and activity coefficient of electrolytes
6. Determination of thermodynamic constants, ΔG, ΔS, and ΔH for the reaction by e.m.f method. $Zn + H_2SO_4 \rightarrow ZnSO_4 + 2H$

SERIES OF EXPERIMENTS ON ADSORPTION

1. To investigate the adsorption of oxalic acid from aqueous solution by activated charcoal and examine validity of classical adsorption isotherm
2. To investigate the adsorption of acetic acid from aqueous solution by activated charcoal and examine validity of classical adsorption isotherm.

Suggested Books:

1. Experiments in General Chemistry; C.N.R. Rao; U.C. Agarwal, East West-Press Pvt. Ltd.
2. Vogel's Text Book of Practical Organic Chemistry, Fifth Edition, B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell; Adission – Wesley Longman Ltd.
3. Practical Organic Chemistry, Fourth Edition; P.C. Mann, B.C. Sounders; Orient Longman Ltd.
4. Experimental Organic Chemistry, Vol. I, P.R. Singh, D.S. Gupta, K.S. Bajpai, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
5. Advanced Practical Physical Chemistry; Twenty-second Edition; J.B.Yadav; Goel Publishing House.
6. Vogel's Textbook of Quantitative Chemical Analysis, G.H.Jeffery, J.Bassett, J. Mendham and R.C. Denney, Publ ELBS, Longman, UK
7. Synthesis and Characterization of Inorganic Compounds, W.L.Jolly, Prentice Hall.
8. Experiments and Techniques in Organic Chemistry, D. Pasto, C.Johnson and M.Miller, Prentice Hall
9. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C.Heath.
10. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
11. Handbook of Organic Analysis – Qualitative and Quantitative, H. Clark,Adward Arnold.

MASTER OF SCIENCE

Subject : Chemistry

Semester III

Paper code	Paper Title	Type of paper	Contact Hours Per semester	Per week	Maximum marks	Minimum marks
MCHE301	Photochemistry	Theory	60	4	100	40
MCHE302	Bioorganic chemistry	Theory	30	2	50	20
MCHE303	Environmental chemistry-II	Theory	30	2	50	20
MCH304	Elective-I Organic synthesis-I	Theory	60	4	100	40
MCHE305	Elective-II Natural products-I	Theory	60	4	100	40
MCHE306	ElectiveIII Heterocyclic Chemistry-I	Theory	60	4	100	40
MCHE351	Inorganic chemistry Practicals	Lab work	90	6	100	
MCHE352	Organic chemistry Practicals	Lab work	90	6	100	
				32	700	

SCHEME OF EXAMINATION

(Semester Scheme)

Examination scheme

Sr. No.	Paper	ESE	CIA	Total
1.	Theory	70%	30%	100
2.	Practical	60%	40%	100

Each theory paper syllabus is divided into four units. Each theory paper 3 hours duration

Each Practical /Lab work 6 hours duration

The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for the paper concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

Note: Maximum marks for a paper(I-IV) is 100 marks which include 70 marks for ESE and 30 marks for internal assessment.

Maximum marks for a paper(V-VI) is 50 marks which include 35 marks for ESE and 15 marks for internal assessment.

Total marks for each semester practicals is 100, which include 60 marks for ESE and 40 marks for internal assessment.

MASTER OF SCIENCE

Subject : Chemistry

Semester III

Paper I-IV

Max.hrs: 3 hrs. **Max. marks : 70**

Part A- comprises of eight short answer questions with two questions from each unit.. (It's a compulsory question and attempt any seven) 2x7= 14marks

Part B- comprises of eight long answer questions with two questions from each unit. Candidates have to answer four questions, selecting one question from each unit. 14x4 = 56 marks

Total marks for End of Semester Examination 70 marks

Internal Assessment 30 marks

Total 100 marks

Paper V-VI

Max.hrs: 3 hrs. **Max. marks : 35**

Part A- comprises of eight short answer questions with two questions from each unit.. (It's a compulsory question and attempt any seven) 1x7= 7marks

Part B- comprises of eight long answer questions with two questions from each unit. Candidates have to answer four questions, selecting one question from each unit. 7x4 = 28 marks

Total marks for End Semester Examination 35 marks

Internal Assessment 15 marks

Total 50 marks

PAPER I Photochemistry MCHE 301 **60 Hrs (4 hrs/week)**

Unit I

Electromagnetic radiation, photochemical excitation – interaction of electromagnetic radiation with organic molecules, types of excitations ($\pi \rightarrow \pi^*$, $n \rightarrow \pi^*$ etc.) fate of excited molecules - Jablonskii diagram, intersystem crossing, energy transfer, photosensitization, quenching, quantum yield, Determination of reaction mechanis : Classification, rate constants and life time of reactive energy states – determination of rate constants of reaction , effect of light intensity on the rate of photochemical reactions , Types of photochemical reaction –photo dissociation , gas – phase photolysis.

Unit II

Photochemical Reactions of Carbonyl Compounds

Photochemical reactions of ketones – alpha cleavage or Norrish type I cleavage, gamma hydrogen transfer or Norrish type II cleavage; photo reductions; Paterno-Buchi reactions; photochemistry of α,β-unsaturated ketones, cis-trans isomerization, β,γ-unsaturated ketones, cyclohexadienones (cross conjugated and conjugated).

Unit III

Photochemistry of Alkenes

Photochemistry of alkenes: Intramolecular reactions of the olefinic bond – cis-trans isomerisation (stilbene), cyclization reactions, rearrangement of 1, 4 and 1, 5-dienes.

Photochemistry of aromatic compounds: Photochemical rearrangement, photostationary state, 1, 3, 5 – trimethyl benzene to 1, 2, 4-trimethyl benzene, di-π methane rearrangement.

Unit IV

Photochemistry of aromatic compounds: Isomerisation, addition and substitution; miscellaneous photochemical reactions; photo-fries reaction of anilide, photofries rearrangements, barton reaction, singlet molecular oxygen reaction, photochemical formation of smog, photodegradation of polymers, photochemistry of vision.

Suggested books:

1. Fundamentals of Photochemistry; First Edition; K.K. Rohatagi – Mukherjee; New Age International Publishers Pvt. Ltd., New Delhi, 2005.
2. Molecular Reactions and Photochemistry; First Edition; Charles H. Depuy and Orville L. Chapman; Prentice-Hall of India Pvt. Ltd, New Delhi, 1988.
3. Reaction Mechanism in Organic Chemistry; Third Edition; S.M. Mukherjee and S.P. Singh; Macmillan, India Ltd., New Delhi, 1999.
4. Advanced Organic Chemistry Part A & B; Fourth Edition; Francis A. Carey and Richard J. Sundberg; Kluwer Academic/Plenum Publishers, New York, 2000.
5. Photochemistry; Horsepool.

MASTER OF SCIENCE
Subject : Chemistry
Semester III

PAPER II Bioorganic Chemistry MCHE 302 30 Hrs (2 hrs/week)

Unit I

Enzymes: Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, michael's- menten and lineweaver burk plots, reversible and irreversible inhibition.

Unit II

Mechanism of enzyme action: Transition- state theory, orientation and steric effect, acid –base catalysis, covalent catalysis, strain or distortion, examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase.

Kinds of Reactions catalysed by enzymes: Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulphate, addition and elimination reactions, enolic intermediates in isomerisations reaction, β- cleavage and condensation, some isomerization and rearrangement reactions. Enzymes catalyzed carboxylation and decarboxylation.

Unit III

Co-enzyme chemistry: Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes, structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN,FAD, lipoic acid, vitamin B12, mechanisms of reactions catalyzed by the above cofactors.

Enzyme models: Host guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality biometric chemistry, crown ether, cryptates, cyclodextrins, cyclodextrin- based enzyme models, clixarenes, ionospheres, micelles synthetic enzymes or synzymes.

Unit IV

Biotechnological applications of enzymes: Large scale production and purification of enzymes, techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilized enzymes, use of enzymes in food and drink industry brewing and cheese making, syrups from crown starch, enzymes as targets for drug design , clinical uses of enzymes, enzyme therapy, enzymes and recombinant DNA technology.

Suggested Books

1. Bioorganic Chemistry: A chemical approach to enzyme action, Hermann Dugas and C. Penny, Springer Verlag.
2. Understanding enzymes, Trevor Palmer, Prentice Hall.
3. Enzyme Chemistry: Impact and applications, Ed. Collin J Suckling, Chemistry.
4. Enzyme Mechanisms, Ed. M. I. Page and A. Williams, Royal Society of Chemistry.

MASTER OF SCIENCE
Subject : Chemistry
Semester III

PAPER III Environmental Chemistry - II MCHE 303 30 hrs(2hrs/week)

UNIT I

Environmental Toxicology-

Toxic Heavy Metals : Mercury, lead arsenic and cadmium, causes of toxicity, bioaccumulation, sources of heavy metals, chemical speciation of Hg, Pb, As and Cd, biochemical and damaging effects.

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

Polychlorinated Biphenyls-: Properties, use and environmental continuation and effects.

Polynuclear Aromatic Hydrocarbons- Sources .structures and as pollutants.

UNIT-II

Soil and Environmental Disaters-Soil composition, micro and macronutrients, soil pollution by fertilizers, plastic and metals. Methods of re-mediation of soil. Bhopal gas tragedy, Chernobyl, three mile island, Mininata disease, Sevoso (Italy), London smog.

UNIT-III

Waste Management: Waste classification, Solid Waste disposal and waste management, landfilling, inceneration, dioxins,medical waste, electronic waste, paper waste, sources of water pollution, treatment of waste and sewage, technique of purification and disinfection.

UNIT IV

Natural Resourses , energy and Environment: Mineral resources, metal and non-metals. Wood-A major renewable resources fuel and energy resource: coal, petroleum and natural gas, nuclear fission and nuclear fusion, solar energy, hydrogen world energy resources- consumption and conservation: Environmental management.

Suggested Books:

1. Environmental Chemistry, Colin Baird, W.H.Freeman Co. New York,1998
2. Chemistry of Atmospheres, R.P. Wayne, Oxford.
3. Environment Chemistry, A.K. De Wiley Eastern,2004
4. Environmental Chemistry, S.E. Manahan, Lewis Publishers.
5. Introduction to Atmospheric Chemistry, P.V.Hobbs,Cambridge.
6. Chemistry of the Environment, Thomas G. Spiro, William M. Stigliani
7. Environmental Chemistry, B.K. Sharma

MASTER OF SCIENCE
Subject : Chemistry
Semester III

PAPER IV Organic Synthesis-I MCHE 304 60 Hrs (4 hrs/week)

Unit I

Enolate chemistry

Formation of enolates, kinetic and thermodyanamic control. Reactions of enolate anion with electrophiles: O vs C alkylation. Enolate condensation reactions ; inter and intramolecular aldol condensation, Claisen , Dieckmann, Knovenagel. Stobbe condensation. Mukaiyama aldol reaction, boron enolates, Nozaki-Hiyama-Kishi coupling, stereoselective enolate reactions: diastereoselection, Zimmermann- traxler model, Evans model, Noyori open chain model. Michael addition and related reaction- Michael reaction, Baylis-hillmann reaction, Robinson annelations, α- Halogenations, Reformatsky reaction, Favorskii rearrangement. Mc. Murry coupling reaction.

Unit II

Metal and non-metal mediated oxidation:

Mechanism, selectivity, stereochemistry and applications of Oppenauer oxidation, aromatization, dehydrogenation, cleavage of C=C bonds, ozonolysis, epoxidation using peracids, Baeyer-villger oxidation. Oxidation using DDQ, NBS, lead tetraacetate, selenium dioxide, Ag, Cr and Mn reagents, periodic acid and osmium tetraoxide. DMSO based oxidation. Oxidation of S,Se, N compounds

Hydroboration

Introduction, preparation of alkyl and alkenyl boranes, synthetic transformation: protonolysis, hydrohalogenation, coupling, isomerisation and displacement reactions. Asymmetric hydroboration. Preparation of amines and sulphides via hydroboration.

Unit III

Metal and non metal mediated reduction: mechanism, selectivity, stereochemistry and applications of catalytic hydrogenation (using Pd, Pt and Ni catalyst), Clemmensen reduction. Wolff Kishner reduction, Meerwin Ponndorf Verley reduction, dissolving metal reduction, metal hydride reduction($NaBH_4$, $LiBH_4$, DIBAL), stereoselectivity in hydride reduction, Wilkinson Rh catalysis. Boron in reduction, Hydrolisation, Photoreduction.

UNIT IV

Metallocenes, Nonbenzenoid Aromatics and Polycyclic Aromatic Compounds.

General considerations, synthesis and reactions of some representative compounds (tropone, tropolone, azulene, ferrocene, phenanthrene, fluorine and indene)

Suggested Books:

1. Modern Synthetic Reactions, H.O. House, W.A. Benjamin.
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
3. Advanced Organic Chemistry, Reactions Mechanisms and Structure, J. March, John Wiley.
4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
5. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.
6. Organic synthesis, Smith M.B., Mcgraw Hill, 2002.

MASTER OF SCIENCE

Subject : Chemistry
Semester III

PAPER V Natural Products-I MCHE 305 60 Hrs (4 hrs/week)

Unit I

Terpenoids and Carotenoids-I

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule; stereochemistry and synthesis of the following representative molecules – Citral, Geraniol, α Terpineol, and Menthol

Unit II
Terpenoids and Carotenoids-II

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule; stereochemistry and synthesis of the following representative molecules Farnesol, Zingiberene, Santonin, Phytol, Abietic acid and β-Carotene.

Unit III

Alkaloids
Definition, nomenclature, physiological action, occurrence, isolation general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring. Role of alkaloids in plants. Structure, stereochemistry and synthesis of the following – Ephedrine, (+)-Nicotine and Morphine, Reserpine, quinine and coniine.

Unit IV

Natural pigments

Occurrence, nomenclature and general methods of structure determination. Isolation, structure determination and synthesis of luteolin, quercetin, myrcetin, quercetin 3- glucoside, diadzein, butin, butein, cyanidin chloride, cyanidin- 7-arabinoside and alizarin.

Suggested Books:

1. Natural products : Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harbome, Longman, Esses.
2. Organic Chemistry: Vol. 2I L. Finar, ELBS.
3. Stereoselective Synthesis : A practical approach , M.Norgradi, VCH.
4. Chemistry of Natural products : S.V. Bhat,B.A.Nagasampagi and M. Sivakumar, Narosa publishing house.
5. Chemistry, Biological and Pharmacological properties of medicinal plants from the Americas, Ed. Kurt Hostettmann,M.P. gupta and A. Martson, Harwood Academic publishers.

MASTER OF SCIENCE
Subject : Chemistry
Semester III

PAPER VI Heterocyclic Chemistry - I MCHE 306 60 Hrs (4 hrs/week)

Unit I

Nomenclature of Heterocycles
Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged Heterocycles.

Aromatic heterocycles
General chemical behaviour of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in ^{1}H NMR-spectra, Empirical resonance energy, delocalization energy and Dewar resonance energy, diamagnetic susceptibility exaltations), Heteroaromatic reactivity

Unit II

Non-aromatic Heterocycles
Strain-bond angle and torsional strains and their consequences in small ring heterocycles.

Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction; Stereo-electronic effects anomeric and related effects; Attractive interactions – hydrogen bonding and intermolecular nucleophilic-electrophilic interactions.

Unit III

Small ring Heterocycles- Three membered and Four membered Heterocycles

Synthesis and reactions of aziridines, oxiranes, thiiranes,oxaaziridines, azetidines, oxetanes, thietanes.

Unit IV

Five membered Heterocycles withTwo Heteroatoms

Synthesis and reactions of 1,2 and 1,3 diazoles, oxazoles and thiazoles

Benzo-fused five membered Five membered Heterocycles

Synthesis and reactions including medicinal applications of benzopyrroles, benzofurans, benzothiophenes.

Suggested Books:

1. Heterocyclic Chemistry Vol. 1-3; First Edition; R.R. Gupta, M. Kumar and V. Gupta; Springer Verlag, Berlin, Heidelberg, 1998.
2. Heterocyclic Chemistry; Fourth Edition; J.A. Joule and K.Mills; Blackwell Science Ltd., London, 2000.
3. Heterocyclic Chemistry; T.L. Gilchrist; Longman Scientific and Technical.
4. An Introduction to the Chemistry of Heterocyclic Compounds; Second Edition; R.M. Acheson; John Wiley and Sons, New Delhi, 1976.
5. Contemporary Heterocyclic Chemistry; G.R. Newkome and W.W. Paudler; Wiley Interscience.

MASTER OF SCIENCE

Subject : Chemistry

Semester III

Practicals

Note: Total marks for each semester practicals is 100, which include 60 marks for ESE and 40 marks for internal assessment.

Duration 6 hours Max. Marks: 60

MCHE 351 Inorganic Chemistry

a) Separation and determination of two metal ions involving volumetric and gravimetric methods

or

Paper chromatographic separation of two metal ions and determination of Rf value 25 marks

b) Preparation of one selected inorganic compound and its study by IR 15 marks

Record 10 marks

Viva 10 marks

Duration 6 hours Max. Marks: 60

MCHE 352 Organic Chemistry

a) Separation, purification and identification of compounds of binary mixture { (one liquid and one solid) or (two solids)} using chemical test and form their derivatives

or

Extraction of organic compounds from natural resources 22 marks

b) Preparation of one selected organic compound 18 marks

Record 10 marks

Viva 10 marks

Inorganic Chemistry Practicals MCHE 351 90 Hrs (6 hrs/week)

Quantitative analysis: Separation and determination of two metal ions Cu-Ni, Ni-Zn, Cu-Fe etc. involving volumetric and gravimetric methods.

Chromatographic separation

1. Separation of Cd^{+2} ,Cu^{+2} ion by paper chromatography and determination of Rf value
2. Separation of Ni^{+2} ,Cu^{+2} ion by paper chromatography and determination of Rf value

Preparation

Preparation of selected inorganic compounds and their studies by I.R. spectra, Mossbauer, E.S.R and magnetic susceptibility measurements. Handling of air and moisture sensitive compounds.

1.Trans- Bis glycinato copper monohydrate
2. Cis- Bis glycinato copper monohydrate
3. Copper chloride DMSO complex
4. Sodium tetrathionate

MASTER OF SCIENCE
Subject : Chemistry
Semester III

Organic Chemistry Practical MCHE 352 90 Hrs (6 hrs/week)

Qualitative Analysis: Separation, purification and identification of compounds of binary mixture { (one liquid and one solid) or (two solids)} using chemical test and form their derivatives

Multistep Organic Synthesis

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

i. Benzene → Benzophenone → benzophenone oxime → benzanilide (Beckmann rearrangement)
ii. Benzoin → benzil → benzilic acid (Benzilic acid rearrangement)
iii. Benzoin → benzil → dibenzyl
iv. Benzophenone → benzopinacol → benzapinacolone (Photochemical reaction))
v. Phthalic anhydride → phthalimide → anthranilic acid → methyl red
vi. Phthalic anhydride → phthalimide → anthranilic acid → o-chloro benzoic acid

Synthesis of heterocyclic compound

i. Phenylhydrazine → 2-phenylindole

Extraction of organic compounds from natural resources

i. Isolation of caffeine from tea leaves
ii. Isolation of casein from milk
iii. Isolation of lactose from milk
iv. Isolation of nicotine dipicrate from tobacco
v. Isolation of piperine from black pepper
vi. Isolation of lycopene from tomatoes
vii. Isolation of eugenol from cloves
viii. Isolation of β- carotene from carrots.

Suggested Books:

1. Vogel's Text Book of Practical Organic Chemistry, Fifth Edition, B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell; Adission – Wesley Longman Ltd. England, 1998.
2. Practical Organic Chemistry, Fourth Edition; P.C. Mann, B.C. Sounders; Orient Longman Ltd.
3. Vogel's Qualitative Inorganic Analysis, Sixth Edition; G. Svehla; Orient Longman, New Delhi, 1987.
4. Infrared and Raman Spectra; Inorganic and co-ordination Compounds, Fifth Edition Part A & B; K.Nakamoto; John Wiley and Sons, Inc., New York, 1997.

MASTER OF SCIENCE
Subject : Chemistry

Semester IV

Paper code	Paper Title	Type of paper	Contact Hours Per semester	Per week	Maximum marks	Minimum marks
MCHE401	Green chemistry	Theory	60	4	100	40
MCHE402	Elective-I, Organic synthesis II	Theory	60	4	100	40
MCHE403	Elective-II, Medicinal Chemistry and Natural Products II	Theory	60	4	100	40
MCHE404	Elective-III, Heterocyclic Chemistry II	Theory	60	4	100	40
MCHE 451	Inorganic Chemistry Practical	Practical	90	6	100	
MCHE 452	Organic Chemistry Practical	Practical	90	6	100	
MCH453	Seminar	-			100	
					700	

SCHEME OF EXAMINATION
(Semester Scheme)

Examination scheme

Sr. No.	Paper	ESE	CIA	Total
1.	Theory	70%	30%	100
2.	Practical	60%	40%	100

Each theory paper syllabus is divided into four units. Each theory paper 3 hours duration

Each Practical /Lab work 6 hours duration

The number of papers and the maximum marks for each paper/ practical shall be shown in the syllabus for the paper concerned. It will be necessary for a candidate to pass in theory part as well as practical part of a subject separately.

Note: Maximum marks for a paper(I-IV) is 100 marks which include 70 marks for ESE and 30 marks for internal assessment.

Total marks for each semester practicals is 100, which include 60 marks for ESE and 40 marks for internal assessment.

MASTER OF SCIENCE

Subject : Chemistry

Semester IV

Paper I-IV

Max.hrs: 3 hrs. **Max. marks : 70**

Part A- comprises of eight short answer questions with two questions from each unit.. (It's a compulsory question and attempt any seven) 2x7= 14marks

Part B- comprises of eight long answer questions with two questions from each unit. Candidates have to answer four questions, selecting one question from each unit. 14x4 = 56 marks

Total marks for End Semester Examination 70 marks

Internal Assessment 30 marks

Total 100 marks

PAPER I Green Chemistry MCHE 401 60 Hrs (4 hrs/week)

Unit I

Introduction, Principle and Concepts of Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Inception and evolution of Green Chemistry.

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Green chemistry in day to day life.

Unit II

Non-Traditional Greener alternative approaches

Different approaches to green synthesis (a) Uses of green reagents in green synthesis- dimetyl carbonate, polymer supported reagents- peracids and chromic acids. (b) Green catalysis, oxidation catalysts, basic catalyst and polymer supported catalyst. (c) Phase transfer catalyst in green synthesis; advantages of PTC reactions to green synthesis, application of PTCs in N/C- alkylation, Darzen's reaction, Wittig reaction, heterocyclic compounds -3-alkylcoumarins, flavanones, oxidation using hydrogen peroxide under PTC conditions, use of crown ethers in esterifications, aromatic substituions and elimination reactions (d) Bioctalysts in organic synthesis: Introduction , microbial oxidation and reduction, production of fine chemicals.

Unit III

Application of non conventional energy sources:Microwave induced and Ultrasound assisted green synthesis

Introduction of Microwave induced organic and inorganic synthesis; Microwave activation equipment,time and energy benefits, limitations. (a) Synthesis of N-O/ S donor ligands and their coordination complexes; synthetic organic transformations under microwaves (b) reactions in organic solvents- Esterification reactions, Fries rearrangement, Diels- Alder reaction, decarboxylation.(c) Solvent free reactions (Solid state Reactions) - Deacetylation, deprotection, saponification of esters, alkylation of reactive methylene compounds, synthesis of nitriles from aldehydes, heterocyclic synthesis –β- Lactums, pyrrole, quinoline.

Ultrasound assisted green synthesis: Introduction, instrumentation, physical aspects, oxidation, reduction, addition, substitution reactions and synthesis of chromenes.

Unit IV

Environmentally Benign solution to organic solvents (focus on water and ionic liquids)

(a) Ionic liquids as green solvents – Introduction, properties and types of ionic liquids: synthetic applications- : Diels-Alder Reaction, Heck reaction, epoxidation, preparation of pharmaceutical compounds; enzyme catalysed synthesis. (b) Aqueous Phase Reactions- Introduction, pseudo organic solvents.

i) Application in oxidation of nitro, aromatic and carbonyl compounds, reduction of carbon-carbon multiple bonds, Claisen rearrangement, Michael reaction, Knoevenagel reaction, benzoin condensation

ii) Electrochemical Synthesis – Introduction, synthesis of sebacic acid, adiponitrile.

Introduction on role of florus solvents and supercritical carbon diooxide in green chemistry.

Suggested Books:

1. Green Chemistry: Theory and Practice. P.T. Anastas and J.C. Warner. Oxford University Press.
2. New trends in green chemistry, V.K. Ahluwalia and M. Kidwai.
3. Green Chemistry: Introductory Text. M. Lancaster Royal Society of Chemistry (London)
4. Introduction to Green Chemistry. M.A. Ryan and M.Tinnesand, American Chemical Society (Washington)
5. Real World Cases in Green Chemistry. M.C. Cann and M.E. Connelly. American Chemical Society (Washington)
6. Real World Cases in Green Chemistry (Vol 2). M.C. Cann and T.P.Umile. American Chemical Society (Washington)
7. Green Chemistry : Environmental Benign Reaction, V.K.Ahluwalia Ane Books, New Delhi ,2009
8. Green Chemistry : Environmental Friendly Alternatives ,Rashmi Sanghi ,M.M.Srivastava , Narosa Publishing House ,2006
9. Green Chemistry : Environmental Benign Reaction, V.K.Ahluwalia Ane Books, New Delhi ,2009
10. Green Chemistry : Environmental Friendly Alternatives ,Rashmi Sanghi ,M.M.Srivastava , Narosa Publishing House ,2006

MASTER OF SCIENCE
Subject : Chemistry
Semester IV

PAPER II Organic Synthesis- II MCHE 402 60 Hrs (4 hrs/week)

Unit I

Disconnection Approach

An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions, amine synthesis.

Protecting groups

Principle of protection of alcohols, amines, carbonyl and carboxyl groups, simple practice exercise

Unit II

One and Two Group C-C Disconnections

One group C-C disconnection involving Alcohols and carbonyl compounds, regioselectivity, alkene synthesis, uses of alkynes and aliphatic nitro compounds in organic synthesis

Diels' Alder reaction, 1,3-difunctionalised compounds, α,β-unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalised compounds; Michael addition and Robinson annelation.

Unit III

Ring synthesis - I

Introduction to ring synthesis of saturated heterocycles. General strategy and stereoselectivity. Three membered rings; cyclisation and insertion reactions. Rearrangements in synthesis. 4- membered rings: photocycloadditions and use of ketenes.

Unit IV

Ring synthesis - II

Five membered rings; from 1,4 and 1,6 dicarbonyl compounds. Pericyclic rearrangements and special methods. Six membered rings: carbonyl condensation, Diels Alder reaction, reduction of aromatic compounds.

Suggested books:

1. Designing Organic Synthesis; First Edition; S. Warren; John Wiley and Sons, Great Britain, 2002.
2. Organic Synthesis- Concepts, Methods and Starting Materials; J. Fuhrhop and G.Penzillin; Verlage VCH.
3. Some Modern Methods of Organic Synthesis; Third Edition; W. Carruthers; Cambridge Univ. Press, UK, 1987.
4. Advanced Organic Chemistry: Reactions, Mechanisms and Structure; Fourth Edition; Jerry March; John Wiley and Sons Asia Private Limited, New Delhi, 2007
5. Principles of Organic Synthesis; Third Edition; R.O.C. Norman and J.M. Coxon; Nelson Thornes, UK, 2003.
6. Advanced Organic Chemistry Part A & B; Fourth Edition; Francis A. Carey and Richard J. Sundberg; Kluwer Academic/Plenum Publishers, New York, 2000.
7. Organic Chemistry, Vol 2; Fifth Edition; I.L. Finar; Longman Scientific and Technical, Singapore, 1997.
8. Rodd's Chemistry of Carbon Compounds; Ed. S. Coffey; Elsevier.

MASTER OF SCIENCE
Subject : Chemistry
Semester IV

PAPER III Medicinal Chemistry and Natural Products-II MCHE 403 60 Hrs (4 hrs/week)

Unit I

Porphyrins

Structure elucidation and synthesis of Haemoglobin and Chlorophyll.

Prostaglandins

Occurrence, nomenclature ,classification , biogenesis and physiological effects.

Unit II

Vitamins

Introduction, synthesis, biological function and deficiency syndromes of vitamin B (Thiamine), E, C, K

Pyrethroids

Introduction, structure elucidation and synthesis of pyrethroids namely pyrethrines and cinerins. Structure activity relationship and synthesis of various synthetic pyrethroids.

Rotenoids

Introduction, isolation, stereochemistry and classification, Synthesis of Rotenones.

Unit III

Steroids

Occurrence, nomenclature, basic skeleton, Diels' hydrocarbon and stereochemistry. Isolation, Structure determination and synthesis of Cholesterol, Androsterone, Testosterone, Estrone, bile acids, progestrone.

Unit IV

Important Chemotherapeutic Agents

Antihistamines (diphenhydramine hydrochloride, promethazine hyrdrochloride, chloro-cyclizine hydrochloride). Analgesics (methadone, dipipanane). Antiviral agents (methisazone, idoxuridines) Antipyretics (phenacetin, paracetamol) Antimalarials (aminoquinolines, pyrimidine) Anticancer agents/Antineoplastic agents (euclophosphamide, chlorambucil, melphalan, busulphan, azathioprine, taxol, CCNU) New developments, e.g., gene therapy and drug resistance.

Suggested Books:

1. Natural products : Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harbome, Longman, Esses.
2. Organic Chemistry: Vol. 2I L. Finar, ELBS.
3. Stereoselective Synthesis : A practical approach , M.Norgradi, VCH.
4. Chemistry of Natural products : S.V. Bhat, B.A.Nagasampagi and M. Sivakumar, Narosa publishing house.
5. Chemistry, Biological and Pharmacological properties of medicinal plants from the Americas, Ed. Kurt hostettmann, M.P. gupta and A. Martson, Harwood Academic publishers.

MASTER OF SCIENCE
Subject : Chemistry
Semester IV

PAPER IV Heterocyclic Chemistry II MCHE 404 60 Hrs (4 hrs/week)

Unit I

Five membered Heterocycles with more than two Heteroatoms

Synthesis and reactions of triazoles, tetrazoles, oxadiazoles and thiadiazoles

Meso-ionic Heterocycles

General classification, chemistry of some important meso ionic heterocycles of type A and B and their applications

Unit II

Six-Membered Heterocycles with one Heteroatoms

Synthesis and reactions of pyrilium salts , pyrones coumarins and chromones.

Six-Membered Heterocycles with two or more heteroatoms

Synthesis and reactions of diazines, triazines, tetrazines

Unit III

Seven Membered Heterocyclic Compounds: Azepines, Oxepins and Thiepins
Diazepines: 1,4 or 1,5 benzodiazepnies
Thiazepines: 1,4 or 1,5 benzothiazepnies

Unit IV

Thiazines: 1,4-benzothiazines and phenothiazines
Bicyclic Ring Systems Derived from Pyridine: Quinoline and Isoquinoline, Acridines and Phenanthridines

Suggested Books:

1. Heterocyclic Chemistry Vol. 1-3; First Edition; R.R. Gupta, M. Kumar and V. Gupta; Springer Verlag, Berlin, Heidelberg, 1998.
2. Heterocyclic Chemistry; Fourth Edition; J.A. Joule and K.Mills; Blackwell Science Ltd., London, 2000.
3. Heterocyclic Chemistry; T.L. Gilchrist; Longman Scientific and Technical.
4. An Introduction to the Chemistry of Heterocyclic Compounds; Second Edition; R.M. Acheson; John Wiley and Sons, New Delhi, 1976.
5. Contemporary Heterocyclic Chemistry; G.R. Newkome and W.W. Paudler; Wiley Interscience.

MASTER OF SCIENCE
Subject : Chemistry
Semester IV
Practicals

Note: Total marks for each semester practicals is 100, which include 60 marks for ESE and 40 marks for internal assessment.

Duration 6 hours — Max. Marks: 60

MCHE 451 Inorganic Chemistry

a) Spectrophotometric determination — 25 marks
b) Flame photometric determination
or
Volumetric determination — 15 marks
Record — 10 marks
Viva — 10 marks

Duration 6 hours — Max. Marks: 60

MCHE 452 Organic Chemistry

a) Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid or two solids and one liquid), using chemical test and form their derivatives. — 25 marks
b) Identification of organic compounds by the analysis of their spectral data.
Or
Spectrophotometric determination — 15 marks
Record — 10 marks
Viva — 10 marks

MCHE 453 Seminar — Max. marks: 100
Submission of hard and soft copy — 50 marks
Presentation — 30 marks
Viva — 20 marks

Inorganic Chemistry Practical MCHE 451 90 Hrs (6 hrs/week)

Flame Photometric Determinations

1. Sodium and potassium when present together
2. Lithium/Calcium/barium/Strontium
3. Calcium and magnesium in tap water

Quantitative analysis: volumetric analysis (any three)

i. Determination of chloride ion in water by Mohr's method or by use of adsorption indicator.
ii. Analysis of talcum powder by EDTA titration.
iii. Analysis of hydrogen peroxide by iodometric method.
iv. Determination of percentage purity of boric acid
v. Comparison of an antacid capacity of commercial tablet samples.

Spectrophotometric determination

1.Iron- phenanthroline complex – jobs method of continuous variation
2.Iron- salicylic acid complex – jobs method of continuous variation
3.Estimation of Nickel in Ni-DMG complex by spectrophotometer

MASTER OF SCIENCE
Subject : Chemistry
Semester IV

Organic Chemistry Practical MCHE 452 90 Hrs (6 hrs/week)
Qualitative Analysis

Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid or two solids and one liquid), using TLC for checking the purity of the separated compounds, chemical analysis, IR, PMR and mass spectral data.

Spectrophotometric Estimations

i. Protein
ii. Ascorbic acid
iii. Aspirin
iv. Carbohydrate
v. Cholesterol
vi. Phenol
vii. Tannin

Spectroscopy

Identification of organic compounds by the analysis of their spectral data.

Suggested Books:

1. Spectral Analysis of Organic Compound; Second Edition; Elifford J. Creswell, Olaf, A. Runquist, Malcolm M. Campbell; Longman.
2. Vogel's Text Book of Practical Organic Chemistry, Fifth Edition, B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell; Adission – Wesley Longman Ltd. England, 1998.
3. Practical Organic Chemistry, Fourth Edition; P.C. Mann, B.C. Sounders; Orient Longman Ltd.
4. Vogel's Textbook of Quantitative Chemical Analysis; Fifth Edition; G.H. Jeffery, J. Bassett. J. Mendham, R.C. Denney; Longman Scientific and Technical Publication, England, 1991.