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	Introduction to Analytical techniques and Nanochemistry	Theory	30	2	50	20	3	
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 paperconcerned. 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 forinternal assessment.

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

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 eachunit. 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 onthe 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 orientationof the double bond; effect of substrate structure, attacking base, leaving group and reaction medium on reactivity; mechanismand 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 andeffect 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 $[BH_4]^-$.
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 interscience4.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 **MCHE 106** **30 hrs (2 hrs/week)**

Introduction to Analytical Techniques and Nanochemistry

UNIT I

Electroanalytical Technique:
Introduction to coulometry , conductometry, annodic stripping voltammetry, TGA, DTA and online analyzers.
Introduction, principle, instrumentation and applications of voltammetry, cyclic voltammetry and amperometry.

UNIT II

Chromatographic Techniques:. Chromatographic methods of separation, solvent extraction methods in analysis, Introduction to liquid, adsorption, partition, ion-exchange, exclusion, gel-permeation chromatography, electro-chromatography. Introduction, principle, instrumentation, & applications of gas-chromatography & high-performance liquid chromatography.

Atomic Absorption Spectroscopy:
Introduction, principle, Grotrian diagram, instrumentation, applications, detection limit, sensitivity and disadvantages.

UNIT III

Properties of Nanomaterials :
Introduction: Properties of materials & nanomaterials, role of size and shape in nanomaterials. Electronic Properties: Classification of materials: metal, semiconductor, Insulator, band structures, Brillouin zones, mobility, resistivity.
Magnetic Properties: Superparamagnetism, blocking. Important properties in relation to nanomagnetism.
Optical Properties: Photoconductivity, Optical absorption & transmission, Photoluminescence, Fluorescence, Phosphorescence, Electroluminescence.

UNIT IV

Synthesis and Characterization of Nanomaterials:
Chemical Methods: Metal nanocrystals by reduction, solvothermal synthesis, Photochemical synthesis, Electrochemical synthesis, nanocrystals of semiconductors and other materials by arrested precipitation, thermolysis routes, sonochemical routes, post-synthetic size selective processing. Sol-gel, Micelles and microemulsions.
Characterization of Nanomaterials: TEM, SEM, SPM and XRD

Suggested Books:

1. Menthem J., Denney R.C., Barnes J.D., Thomas M.J.K. , Vogel's text book of chemical analysis 6th edition Prentice Hall 2000.
2. Fifield F.W., Kealey D. Principles and Practice of Analytical Chemistry, Blackwell Science Ltd, 5th edition, 2000.
3. Kenedy J.H., Analytical Chemistry -principles, Cengage Learning, 2nd edition 2011.
4. Christain G.D. Analytical Chemistry, Wiley 7th edition 2013.
5. Fundamental of Analytical Chemistry, Srivastava B.B.L., Mishra A., Innovative Publication, 2019
6. Essentials of Analytical Chemistry, Shobha R., Banani M. Pearson, 1st edition 2017
7. Principles of Instrumental Analysis Skoog D., Holler F.J., Crouch S., Cengage Learning India Pvt. Ltd. 2007
8. Klabunde, K. J., Ed. Nanoscale Materials in Chemistry, Wiley Interscience (2001)
9. Kulkarni, S. K. Nanotechnology: Principles and Practices, Capitol Publishing Company (2007)
10. Wilson, M., Kannangara, K., Smith, G., Simmons, M. & Raguse, B. Nanotechnology: Basic Science and Emerging Technologies, Overseas Press (2005).
11. Edelstein, A.S. & Cammarata, R. C., Ed. Nanomaterials: Synthesis, Properties and Applications, Institute of Physics Publishing (1996).
12. Chattopadhyay K.K., Banerjee A.N. Introduction to Nanoscience and Nanotechnology, PHI learning, 2009

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 (one metal ion in cationic 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 verifythe 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 dissociationconstant 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

durationEach 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 30marks for internal assessment.

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

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

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 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

Semester II

Paper I Inorganic Chemistry **MCHE201** **60 Hours(4Hrs./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 VBTand CFT. Ligand substitution reactions in square planer complexes, trans effect

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 SonsAsia 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.
   $2MnO_4^- + 5C_6H_5CH_2OH + 6H^+ \rightarrow 2Mn^{2+} + 5C_6H_5CHO + 8H_2O$

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
Specialization: Organic Chemistry						
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	
Specialization: Physical Chemistry						
MCH314	Elective-I Advanced Electrochemistry-I	Theory	60	4	100	40
MCHE315	Elective-II Phase Rule and Surface Phenomenon	Theory	30	2	50	20
MCHE316	ElectiveIII Advanced Chemical Kinetics-I	Theory	30	2	50	20
MCHE361	Inorganic Chemistry Practicals	Lab work	90	6	100	
MCHE362	Physical Chemistry Practicals	Lab work	90	6	100	
				32	700	

Examination scheme

SCHEME OF EXAMINATION
(Semester 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-III) is 100 marks which include 70 marks for ESE and 30 marks forinternal assessment.

Maximum marks for a paper (IV-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-VI

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 II-III

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, β,γ-unsaturated ketones, cyclohexadienones (cross conjugated and conjugated).

Unit III

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 heavymetals, 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

Organic Specialization

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

Organic Specialization

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

Organic Specialization

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

Organic Specialization
Practicals

Note: Total marks for each semester practicals are 100, which include 60 marks for ESE and 40marks 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 Specialization

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 III

Physical Specialization

PAPER IV Advanced Electrochemistry -1 MCHE 314 60 Hrs (4 hrs/week)

Unit-I

Electrochemical Energy: Pollution problem. History of fuel cells. Direct energy conversion by electrochemical means. Maximum intrinsic efficiency of an electrochemical converter. Physical interpretation of the Carnot efficiency factor in electrochemical energy convertors.

Electrochemical Generators (Fuel Cells): Hydrogen-oxygen cells, hydrogen Air cell, Hydrocarbon air cell, alkaline fuel cell, phosphoric fuel cell, direct NaOH fuel cells. Applications of fuel cells.

Unit-II

Electrochemical Energy Storage: Properties of Electrochemical energy stores, measure of battery performance. Charging and discharging of a battery, Storage density Energy density Classical

Batteries (i) Lead-Acid (ii) Nickel-Cadmium. (iii) Zinc-Manganese dioxide. Modern batteries: (1) Zinc-Air (ii) Nickel-Hydride, (iii) Lithium Battery. Future electricity stores: storage in (i) Hydrogen, (ii) Alkali metals (iii) Non aqueous solutions

Unit-III

Corrosion; Surface mechanism of the corrosion of the metals, thermodynamics and the stability of metals, potential pH (or pourbaux) diagrams. Uses and abuses, Corrosion current and corrosion potential-Evans diagrams. Measurement of corrosion rate: (i) Weight loss Method (ii) Electro chemical Method. Cathodic and anodic protection (i) Inhibition by addition of substrates to the electrolyte environment (ii) by charging the corroding method from external source, anodic protection, organic inhibitors. The fuller story green inhibitors. Passivation**:** Structure of passivation films. Mechanism of Passivation, Spontaneous Passivation. Nature's method for stabilizing surfaces.

Unit-IV

Bioelectrochemistry: Bio-electrodes, membrane potentials, simplistic theory, modern theory. Electrical conductance in biological organism. Nernst -Plank equation, Hodgkin-Huxley equations, Core conductor model, Electrocardiography, Electronic, protonic electrochemical mechanism of nervous systems, enzymes as electrodes.

Books suggested:

1. Modern Electrochemistry vol. I, IIA Vol. IIB, J'OM Bochris and A.K.N. Reddy, Plenum Publication, New York.

2. Polarographic. Techniques by L. Meites, Inr\terscience.

3. Modern Polarographic Methods by A.M. Bond, Marcell Dekker.

MASTER OF SCIENCE
Subject : Chemistry
Semester III

Physical Specialization

PAPER V Phase Rule and Surface Phenomenon MCHE 315 60 Hrs (4 hrs/week)

UNIT 1

Solution & Phase Equilibrium: Derivation of Gibb's phase rule, phase equilibria of two component systems ;Benzophenone and Diphenylamine ,congruent and incongruent melting points; Benzene and Picric Acid .Distillation of binary mixture of liquids. Zeotropic and Azeotropic mixtures, critical solution temperatures, solubility of gases in liquids, Henry's law, Nernst distribution law, number of extractions, solutions of solids in liquids & chemical equilibrium. Triangular method for graphical representation of three component systems partially miscible three liquid systems. Applications of ternary liquid diagrams

Unit 2

Colloidal State: Classification of colloids, charge and stability of colloidal dispersions, Hardy-Schulze Law, gold number, electrical properties of colloids, electrical double layer and its structure, Stern's theory of double layer, zeta - potential, electrophoresis and electro-osmosis, emulsions and their classification, emulsifiers, gels and their classification, thixotropy. Association colloids, micelle formation, cmc, soap action. Application of colloids.

Unit 3:

Adsorption and Surface Phenomena: Physical and chemical adsorption, adsorption isotherms, Derivation of Langmuir, Freundlich, Tempkin isotherms. Heterogenous catalysis, surface catalyzed unimolecular and bimolecular reactions, retarded surface reactions, temporary and permanent catalytic poisons, activation energy for surface reactions.

Unit 4:

Liquid State: Introduction to liquid state, thermodynamic properties of liquids, vapour pressure and its determination, enthalpy and entropy of vaporization, Trouton's rule. Intermolecular forces. Models and theories of liquids,;Eyring theory, Bernal Scott theory and Oscillator theory . Surface and transport properties Viscosity, thermal conductivity and diffusion. surface tension and its measurement, viscosity and its measurement. X-ray diffraction study of simple liquids and their structure. Specific heat of liquids.

Books Suggested:

1. Principles of Physical Chemistry, S.H. Maron & C.F. Prutton.

2. Solid State Chemistry, C.N.R. Rao.

3. Principles of Solid State Chemistry, P.P. Budnikov & A.M. Ginstling.

4. Physical Chemistry, P.W. Atkins.

5. An introduction to liquid state, P.A Egelstaff, Clarendon Press Publication.

6. Applications of Liquid Crystals, G.Meier, E. Sackmann & J.G. Grabmaier.

MASTER OF SCIENCE
Subject : Chemistry
Semester III

Physical Specialization

PAPER VI Advanced Chemical Kinetics **MCHE 316** **60 Hrs (4 hrs/week)**

Unit-I

Induced Phenomena: Induced reactions, kinetics of Induced reactions and their charateristics Induction factor and its mechanistic significance. Mechanism of-Fe (II) induced oxidation of iodide by Cr (VI), As (III) induced oxidation of Mn (II) by chromate in acid solutions, kinetics and mechanism of induced reactions in metal complexes (octahedral complexes of cobalt (III) only).

Unit-II

Metal ion catalysis: Kinetics and mechanism of following reactions.

(i) When reaction rate is independent of one of the reactants in presence of metal ion catalyst.
(ii) When reaction rate is retarded by one of the products in presence of metal ion catalyst.
(iii) When metal ion catalysis indicates an intermediate species.
(iv) Cyclodextrines are acting as catalyst mode of catalysis. Analysis of one full case study of B-cyclodextrine, catalyzed reaction, hydroformylation reaction.

Unit-III

Oscillatory Reactions: Autocatalysis and oscillatory reactions, thermodynamics approach of oscillatory reactions, Kinetics and mechanism of Belousov- Zhabotinski (B-Z) reaction,

Substitution Reaction: Classification of ligand substitution reaction, kinetics and mechanism of Anation reaction; base catalyzed reaction and acid catalyzed reaction. Kinetics and mechanism of 1:1,1:2 and 1:3 metal – substrate complexes as intermediates.

Unit-IV

Electron Transfer Reactions in Metal Complexes: Inner-sphere and outer-sphere reactions, mechanism of inner sphere and outer sphere mode of electron transfer reactions. Henry Taube's classical reaction, its kinetics and mechanism, experimental analysis by chromatographic and spectroscopic techniques. Pattern of reaction via adjacent and remote attacks, linkage isomerism. Bridged outer-sphere electron transfer mechanism**,** Marcus-Cross-relation in outer-sphere reactions, (no mathematical derivation) in following reactions-

$Fe(CN)_6^{4-} + Fe(CN)_6^{3-} = Fe(CN)_6^{3-} + Fe(CN)_6^{4-}$

Ce (IV) + $Fe(CN)_6^{4-}$ = **Ce (III)** + $Fe(CN)_6^{3-}$

SUGGESTED BOOKS

1.Henry Taube's, S Lippard (Ed.) Progress in inorganic Chemistry, Vol 30, John Wiley & Sons, NY,1983.

2. R. Lumry and R.W. Raymond, Electron transfer reaction, inter-science publication,1997.

3. A.G. Sykes, Kinetics of Inorganic reaction, PergamonPress,1966.

4. N.L. Bender, Mechanism of homogeneous Catalysis from protein to protein, Wiley ,1971.

5. H. Taube, Electron transfer reactions in solution, Academic Press, London,1970

MASTER OF SCIENCE

Subject : Chemistry

Semester III

Physical Specialization

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 361 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 marks

MCHE 362 Physical Chemistry

a) Phase equilibrium 22 marks

b) Chemical Kinetics

or

Liquid and Colloidal State 18 marks

Record 10 marks

Viva 10 marks

Inorganic Chemistry Practicals MCHE 361 90 Hrs (6 hrs/week)

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

(B) Chromatographic separation

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

(C) 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

Physical Chemistry Practicals **MCHE 362** **90 Hrs (6 hrs/week)**

(A) Phase Equillibrium

1. To determine the freezing point depression constant of camphor using naphthalene as solute. Hence determine the molecular weight of acetanilide by Rast's micro method.

2. Determination of molecular weight of a non-volatile substance by measuring elevation of boiling point .

3.To obtain the mutual solubility curve of phenol + H_2O, and hence the Upper consolute point.

4. To determine the distribution coefficient of I_2 between CCl_4 and H_2O.

5.To find the molecular weight of given liquid by steam distillation method.

6. To construct the phase diagram of benzophenone and Diphenylamine.

(B) Chemical Kinetics

1. Determinine the energy of activation and entropy of activation in $KMnO_4$-benzyl alcohol reaction measuring the rate constant at least at three temperatures.

2.Determine the formation constant for $[Ce^{+4} - H_3PO_2]$ intermediate complex and also the rate constant of its decomposition.

3. Determine the rate constant in bleaching of malachite green in the basic medium.

4.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 unanalysed reaction .

(C) Liquid and Colloidal State

3. To prepare and study Hardy – Schulze's rule for arsenious sulphide / Ferric hydroxide sols

7. To determine the coefficient of viscosity of given liquid by Ostwald's viscometer).

8. To find the molecular weight of polymer by viscosity measurements, Determination of surface tension of given liquid by drop no. method by stalagmometer,

Books Recommended:

1. Findlay's Practical Physical Chemistry.

2. Advanced Practical Physical Chemistry by J.B. Yadav.

3. Laboratory Handbook for Oil & Fat Analysis by L.V. Cock and C. van Rede

MASTER OF SCIENCE

Subject : Chemistry

Semester IV

Paper code	Paper Title	Type of paper	Contact Hours Per semester	Per week	Maximum marks	Minimum marks
Organic Specialization						
MCHE 401	Green chemistry	Theory	60	4	100	40
MCHE 402	Elective-I, Organic synthesis II	Theory	60	4	100	40
MCHE 403	Elective-II, Medicinal Chemistry and Natural Products II	Theory	60	4	100	40
MCHE 404	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	
MCH 453	Seminar/Project	-			100	
					700	
Physical Specialization						
MCHE 411	Nanochemistry and Nanocatalysis	Theory	60	4	100	40
MCHE 412	Elective-I, Polymer Chemistry	Theory	60	4	100	40
MCHE 413	Elective-II, Chemistry of Materials	Theory	60	4	100	40
MCHE 414	Elective-III, Advanced Electrochemistry -II	Theory	60	4	100	40
MCHE 461	Organic Practical	Chemistry Practical	90	6	100	
MCHE 462	Physical Practical	Chemistry Practical	90	6	100	
MCH 463	Seminar/Project	-			100	
					700	

Examination scheme **SCHEME OF EXAMINATION**

(Semester 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 eachunit. 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

Organic specialization

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 usingthese 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 florous 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

Organic specialization

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

Organic specialization

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

Organic specialization

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

Organic specialization

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 specialization

Organic Chemistry Practical MCHE 452 90Hr(6hrs/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.

MASTER OF SCIENCE

Subject : Chemistry

Semester IV

Physical Specialization

PAPER- I Nanochemistry and Nanocatalysis MCHE 411 60 Hrs (4 hrs/week)

Unit 1

Basic concepts of nanochemistry : Introduction to nanoscience and nanotechnology, discussion on various phenomenon at nanoscale, such as size, shape, surface, surface energy, surface stabilization, characteristic length, self-assembly, defects, size quantization, surface plasmon, conductivity, tunneling,

Unit – II

Synthesis of nanomaterials: Basics of nanofabrication method, top-down, bottom-up approaches, gas phase, liquid phase, solid phase synthesis, self-assembly, templated synthesis, sol-gel, electrodepostion, fundamentals of nanoparticle formation, thermodynamic approach, supersaturation, nucleation, growth, homo vs hetero nucleation. Synthesis of nanoparticles: metallic, semiconducting, quantum dots, oxides, hybrids, micelles and microemulsion as templates for synthesis. 0D, 1D and 2D nanoparticles, core-shell nanoparticles, special nanoparticles, shaped nanoparticles.

Unit – III

Carbon clusters and nanostructures: Bonding in carbon, new carbon structures, carbon clusters, discovery of C60,alkali doped C60,superconductivity in C60,larger and smaller fullerenes, carbon nanotubes: synthesis, single walled carbon nanotubes, structure and characterization, mechanism of formation, chemically modified carbon nanotubes, doping, functionalizing nanotubes, application of carbon nanotubes, nanowires, synthetic strategies, gas phase and solution phase growth, growth control,

Unit –IV

Nanomaterials for catalysis: Nanocatalysis: fundamentals, homogeneous vs heterogeneous catalysis, effect of surface area, effect of particle size, shape and morphology, effect of composition, bimetallic system etc, nanomaterials for photo-catalysis [dye degradation, water splitting, organic transformations, plasmon assisted photo-catalysis, band gap tuning, etc], nanomaterials for CO_2 capture and conversion.

Suggested books

1.Understanding Nanomaterials -Malkiat.s .Johal ,Lewis E Johnson CRC Press Taylor and Francis London New York

2. Nanotechnology ;Principles and Practices ,Sulabha K. Kulkarni Springer Publication.

3. K. J. Klabunde, Nanoscale materials in Chemistry, Wiley- Interscience, New York, 2001.

4. T. Pradeep, Nano: The Essentials in Understanding Nanoscience and Nanotechnology, Tata McGraw Hill, New Delhi, 2007.

5. T. Tang and P. Sheng, Nano Science and Technology – Novel Structures and Phenomena, Taylor & Francis, New York, 2004.

6. U. Heiz, and U. Landman,Nanocatalysis, Springer, New York, 2006.

MASTER OF SCIENCE
Subject : Chemistry
Semester IV
Physical Specialization

PAPER -II Polymer Chemistry MCHE 412 60 Hrs (4 hrs/week)

Unit 1

Introduction: Classification of polymers, intermolecular forces in polymers. Radical, cationic, anionic and condensation polymerization, copolymerization, reactivity ratios.

Unit II

Mechanism and kinetics of step-growth and chain growth polymerization: Thermodynamic aspects of polymerization, mechanism of living radical polymerizations: nitroxide mediated polymerization (NMP), metal-catalyzed living radical polymerization, reversible addition-Fragmentation Chain Transfer (RAFT) radical polymerization, coordination polymerization, ring opening polymerization, click chemistry.

Unit III

Polymer solutions, Polymer structure and Physical properties: Flory-Huggins theory of polymer solutions, nature, size and shape of macromolecules in solution. Microstructure of polymer chains, crystallinity in polymers, glass transition temperature, rheological properties, molecular weight and its distribution.

Unit IV

Specialty polymers: Liquid crystalline polymers, fire-retarding polymers ,conducting polymers, electroluminescent polymers, inorganic polymer, nanocomposites of polymers, biomedical polymers. chemical analysis of polymers by spectroscopic methods ,X-ray diffraction study of polymers.

Suggested books

1. Text Book of Polymer Science, 3rd Edition (1984), F. W. Billmayer, Jr., Willey-Interscience, New York.

2. Physical Chemistry, 8th Edition, P. W. Atkins, Oxford University Press, New York. YEAR

3. Principles of Polymerization, 3rd Edition (1991) G. Odian, John Wiley, Singapore

4. Principle of Polymer Sciences, P. Bahadur and N.V. Sastry, Narosa Publishing House, New Delhi (2002)

5. Polymer Sciences, V.R. Gowarikar, N.V. Vishwanathan, J. Shreedhar , Wiley Eastern, New Delhi.

MASTER OF SCIENCE

Subject : Chemistry

Semester IV

Physical Specialization

PAPER- III Chemistry of Materials MCHE 413 60 Hrs (4 hrs/week)

Unit I

Liquid Crystals : Mesomorphic behaviour, thermotropic liquid crystal, positional order, bond orientational order, nematic and smectic mesophases; smectic – nematic transition and clearing temperature- homeotropic, planar and schlieren textures, twisted nematics, chiral nematics, molecular arrangement in smectic A and smectic C phases, optical properties of liquid crystal. Dielectric susceptibility and dielectric constants. Lyotropic phases and their description of ordering in liquid crystals.

Unit II

High Temperature superconductors (Tc)Materials : Defect perovskites, high Tc superconductivity in Cuperates, preparation and characterization of 1-2-3 and 2-1-4 materials, normal state properties; anisotropy; temperature dependence of electrical resistance; optical phonon modes, superconducting state; heat capacity; coherence length, elastics constants, position lifetime, microwave absorption-pairing and multigap structure in high Tc materials, applications of high Tc materials.

Unit III

Thin Films and Langmuir- Blodgett Films : Preparation techniques; evaporation/sputtering, chemical process, sol gel etc. Langmuir – Blodgett (LB) films, growth technique, photolithography, properties and applications of thin and LB films.

Unit IV

Glasses, Ceramics and composites : Glassy state, glass formers, and glass modifiers, application. Ceramic structures, mechanical properties, clay particle product. Refractories, characterization, properties, and applications. Microscopic composites; dispersion–strengthened and particle reinforced, fibre- reinforced composite, macroscopic composites.

Suggested books:

1. Solid State Physics, N.W. Ashcrofy and N.D. Mermin, Saunders College.
2. Material Science and Engineering, An Introduction, W.D. Callister, Willey.
3. Principle of the Solid State, H.V. Keer, Willey Eastern.
4. Material Science, J.C. Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings, ELBS
5. Thermotropic Liquid Crystals, Ed., G.W. Gray, John Willey

MASTER OF SCIENCE

Subject : Chemistry

Semester IV

Physical Specialization

PAPER- IV Advanced Electrochemistry-II MCHE 414 60 Hrs (4 hrs/week)

Unit-I

Quantum aspects: Charge transfer at electrode -solution interfaces, quantization of charge transfer tunneling .Semiconductor interfaces**:** Structure of double layer at the semiconductor solution interface,Effect of light at semiconductor -solution interface. Electrochemical methods**:** Controlled potential and current techniques, Hydrodynamic techniques, Electrochemical instrumentation, Scanning probe techniques.

Unit-II

Kinetics of electrode process: Multistep electrode reactions, Mass transfer by diffusion, Irreversible Electrode Processes, Criteria of irreversible information from irreversible wave. Methods of determining kinetic parameters for quasi-reversible and irreversible waves: Koutecky's method. Meits Israel methods, Gelling's method .Electro catalysis chemical catalysis and electrochemical catalysis with special reference to purostates, porphyrin oxides of rare earths, electro catalysis in simple redox reactions, reaction involving adsorbed species, Influence of various parameters.

Unit-III

Bulk Electrolysis Methods: Controlled potential coulometry, controlled coulometry, Electroorganic synthesis and its importance, application, stripping analysis, anodic and cathodic modes, preelectrolysis and stripping steps, application of stripping analysis

Unit-IV

Electrocrystallization: Electro growth of metals on electrode-Nucleation, Growth , Surface Diffusion, Underpotential ,Variety of Shapes formed in electrodeposition ,Electrochemical sensors for Nitric Oxide ,pesticides ,glucose and superoxide species ,Electrochemical sensors based on carbon nanotubes and their applications

Suggested books:

1. Modern Electrochemistry vol. I,IIA Vol. IIB, J'OM Bochris and A.K.N. Reddy, Plenum Publication, New York.
2. Polarographic. Techniques by L. Meites, Interscience.
3. "Fuel Cells; Their electrochemistry" McGraw Hill Book Company New York.
4. Modern Polarographic Methods by A.M. Bond, Marcell Dekker.
5. Polarography and allied technique by K. Zutshi, New Age Publication New Delhi.
6. Electroanalytical Chemistry -Allen J. Bard CRC Press Taylor and Francis -London New York .
7. Topic in Pure and Applied Chemistry. Ed. S.K. Rangrajan, SAEST Publication, Kararikudi (India).
8. Bockris, J.O.M.& Reddy,A.K.N. Modern electrochemistry 2B : Electrodics in Chemistry ,Engineering Biology and Environmental Science 2 nd Ed. Springer (2001)

MASTER OF SCIENCE

Subject : Chemistry

Semester IV

Physical Specialization

Practicals

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

Duration 6 hours — Max. Marks: 60

MCHE 461 organic Chemistry

c) Multistep Organic Synthesis — 25 marks

d) Extraction of organic compounds from natural resources — 15 marks

Record — 10 marks

Viva — 10 marks

Duration 6 hours — Max. Marks: 60

MCHE 462 Physical Chemistry

c) Electrochemistry or Spectrophotometry — 25 marks

d) **Coulometric Titrations** Or

Conductometry — 15 marks

Record — 10 marks

Viva — 10marks

MCHE 463 Seminar\Project — Max. marks: 100

Submission of hard and soft copy — 50 marks

Presentation — 30 marks

Viva — 20 marks

Organic Chemistry Practical **MCHE 461** **90 Hrs (6 hrs/week)**

(A) Multistep Organic Synthesis

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

vii. Benzene → Benzophenone → benzophenone oxime → benzanilide (Beckmann rearrangement)

viii. Benzoin → benzil → benzilic acid (Benzilic acid rearrangement)

ix. Benzoin → benzil → dibenzyl

x. Benzophenone → benzopinacol → benzapinacolone (Photochemical reaction))

xi. Phthalic anhydride → phthalimide → anthranilic acid → methyl red

xii. Phthalic anhydride → phthalimide → anthranilic acid → o-chloro benzoic acid

Synthesis of heterocyclic compound

i. Phenylhydrazine → 2-phenylindole

(B) Extraction of organic compounds from natural resources

ix. Isolation of caffeine from tea leaves

x. Isolation of casein from milk

xi. Isolation of lactose from milk

xii. Isolation of nicotine dipicrate from tobacco

xiii. Isolation of piperine from black pepper

xiv. Isolation of lycopene from tomatoes

xv. Isolation of eugenol from cloves

xvi. Isolation of β- carotene from carrots.

Suggested Books:

5. 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.
6. Practical Organic Chemistry, Fourth Edition; P.C. Mann, B.C. Sounders; Orient Longman Ltd.
7. Vogel's Qualitative Inorganic Analysis, Sixth Edition; G. Svehla; Orient Longman, New Delhi, 1987.
8. Infrared and Raman Spectra; Inorganic and co-ordination Compounds, Fifth Edition Part A & B; K.Nakamoto; JohnWiley and Sons, Inc., New York, 1997.

Physical Chemistry Practical MCHE 462 90 Hrs (6 hrs/week)

(A)Electrochemistry/Spectrophotometry

1.Determination of the strength of strong and weak acids in a given mixture using a potentiometer/pH meter.
2. Determination of the formation constant of silver – ammonia complex and stoichiometry of the complex potentiometrically**.**
3.Spectrophotometric estimation of amino acids, proteins, carbohydrates etc.

(B) Coulometric Titrations

1.Determine coulometrically the concentration of Nickel and Cobalt from a given mixture.
2.The coulometric titration of cyclohexene.

(C) Conductometry

1. To determine the equivalent conductivity at infinite dilution of a weak electrolyte (acetic acid, NH_4OH) by making use of Kohlrausch's law.
2. To determine the dissociation constant of a weak acid (acetic acid) by conductivity method by plotting equivalent conductivity ($\sqrt{c}$) and obtaining the slope of the straight line passing through the origin. Slope is equal to $\wedge \propto \sqrt{k}$.
3. To determine the equivalent conductance of the strong electrolytes (KCl, NaCl, HNO_3, HCl etc.) at several concentrations and verify Osanger equation.

$\wedge v=\wedge \infty-(A\wedge \infty+B)\sqrt{c}$. Find out the values of A and B.

4. Determination of acid and base dissociation constants of an amino acid and hence the iso -electric point of the acid.
5. The determine the composition of the complex of Cu(II) and EDTA by the Conductometric method / potentiometric method.
6. Amperometric titration of lead solution with potassium dichromate
7.To determine the ionization constant of polybasic acid phosphoric acid potentiometrically

Books Recommended:

1. Findlay's Practical Physical Chemistry.
2. Advanced Practical Physical Chemistry by J.B. Yadav.
3. Laboratory Handbook for Oil & Fat Analysis by L.V. Cock and C. van Rede