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

MASTER OF SCIENCE
Chemistry

Semester I
Semester Scheme

Paper Code	Paper title	Course Category	Credit	Total contact hours per semester / per week		Maximum Marks	Minimum Marks	ESE in hrs	
								Theory	Practical
MCHE101	Inorganic Chemistry	DSC	4	60	4	100	40	3	-
MCHE102	Organic Chemistry	DSC	4	60	4	100	40	3	-
MCHE103	Physical Chemistry	DSC	4	60	4	100	40	3	-
MCHE104	Spectroscopy 1	DSC	4	60	4	100	40	3	-
MCHE105	Bioinorganic Chemistry	DSC	2	30	2	50	20	3	-
MCHE106	Introduction to Analytical techniques and Nanochemistry	DSC	2	30	2	50	20	3	-
MCHE151	Inorganic Chemistry Practical	DSCP	6	90	6	100	40	-	6
MCHE152	Physical Chemistry Practical	DSCP	6	90	6	100	40	-	6
			32			700			

The details of the courses with code and title assigned are given below.
DSC= Discipline Specific Core ESE = End Semester Examination DSCP = Discipline Specific Core Practical

Examination Scheme

S.No.	Paper	ESE	CIA	Total
	Theory	**70%**	**30%**	**100%**
	Practical	**60%**	**40%**	**100%**

Syllabus of each theory paper is divided into four units. Each theory paper is of 3 hours duration. Each Practical /Lab work is of 6 hours duration.

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

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

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Semester Scheme

Maximum marks for a theory paper (V-VI) are 50 which includes 35 marks for ESE and 15 marks for internal assessment.
Maximum marks for each practical is 100 which includes 60 marks for ESE and 40 marks for internal assessment.

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Examination Scheme

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 is compulsory to attempt any seven question)	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 = 56marks
	Total marks for End of Semester Examination	**70 marks**
	Internal Assessment	**30 marks**
	Total	**100 marks**

Paper V-VI

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

Part A	Comprises of eight short answer questions with two questions from each unit. (It is compulsory to attempt any seven question)	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**

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MASTER OF SCIENCE
Chemistry

Semester I
Paper I

MCHE 101 **Inorganic Chemistry** **60 Hrs (4 hrs/week)**

Unit I

Stereochemistry and Bonding in main group Compounds: VSEPR Theory, 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 (d^1 to d^9 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, Optical Circular Dichroism (ORD), circular dichroism (CD) and magnetic properties of transition metal complexes, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Learning Outcomes:

Students will be able to:

- analyze the basics of stereochemistry , metal-ligand bonding in compounds, Walsh diagrams, CFT , MOT and quantify ionic character and back bonding and charge transfer phenomena
- understand charge transfer spectra and implement knowledge in assigning absolute configuration of optically active chelates.

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

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MASTER OF SCIENCE
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Semester I
Paper II

MCHE 102 **Organic Chemistry** **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 Reactions: 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, and regioselectivity.
Aromatic Nucleophilic SubstitutionReactins: S_NAr, S_N1, benzyne and SR_N1 mechanism; effect of substrate structure, leaving group and attacking nucleophiles on reactivity.

Unit III

Aliphatic Electrophilic Substitution Reactions: Bimolecular mechanism –SE2 and SEi; the SE1 mechanism, substitution by double bond shift, addition-elimination mechanism and cyclic mechanism, effect of substrates, leaving group and solvent polarity on the reactivity,
Aromatic Electrophilic Substitution Reactions: 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 insubstrates 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 carboxylicacid, coupling of alkynes.

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Semester I
Paper II

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

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 cyclopropanering, Sharpless asymmetric epoxidation.
Wittig reaction. Mechanism of condensation reactions involving enolates – Mannich, Benzoin and Perkin reactions.

Elimination Reactios: E_2, E_1, E_1CB and E_2C (syn elimination) mechanisms; E1 – E2 – E1CB spectrum; Steric orientationof the double bond; effect of substrate structure, attacking base, leaving group and reaction medium on reactivity, mechanism and orientation in pyrolytic elimination.

Learning Outcomes:

Students will be able to:

- analyse and evaluate the most commonly encountered reaction mechanisms in organic chemistry.
- predict and simulate mechanism of newly synthesized organic compounds and communicate recent findings in this field.

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.

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Semester I
Paper III

MCHE 103 **Physical Chemistry** **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 values and Eigen functions for 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. Applications 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 & Hinshelwood theories of unimolecular reactions. Kinetics of enzyme reactions, homogenous catalyst, photochemical reactions (hydrogen bromine and hydrogen chlorine**),** dynamic chain reaction (H-Br reaction)**,** general features of fast reactions, study of fast reactions 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.

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

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Semester I
Paper III

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

Learning Outcomes:

Students will be able to:

- investigate the fundamental concepts of quantum mechanics to illustrate some model systems and compute approximation methods.
- deduce kinetic and thermodynamic aspects of chemical reactions and analyze advanced electrochemical concepts and theories.

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.

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Semester I

Paper IV

MCHE 104 **Spectroscopy-I** **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, non rigid rotors, Stark effect, nuclear and electron spininteraction and effect of external fields; applications.

Unit II

Vibrational Spectroscopy: Infra Red 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 (briefidea).

Unit III

Electronic Spectroscopy

Atomic Spectroscopy: Energy of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogenatom 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

Electron Spin Resonance Spectroscopy: Hyperfine coupling, spin polarization for atoms and transition metal ions, spin orbit coupling and significance of g-tensors, applications to transition metal complexes (having one unpaired electron) including biological systems and inorganic free radicals such as H, PH_4^-, F^- and $[BH]^-$.

Mössbauer spectroscopy: Basic principles, spectral parameters and spectrum display, applications 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.

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Paper IV

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

Learning Outcomes:
Students will be able to:

- demonstrate and interpret the electromagnetic spectra and apply it in the study of chemical molecules.
- explain the principles of microwave spectrometry, Electronic Spectroscopy, ESR and Mössbauer Spectroscopy

Suggested Books:

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

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Semester I

Paper V

MCHE 105 **Bioinorganic Chemistry** **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: Haem proteins and oxygen uptake. Structure and functions of haemoglobin and 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.

Learning Outcomes:

Students will be able to:

- define importance of inorganic elements in vital systems
- ***explain*** the role of nitrogen fixing bacteria and interpret situations that may occur in the absence of minerals.

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

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Semester I

Paper VI

MCHE 106 Introduction to Analytical Techniques and Nanochemistry 30 hrs (2hrs/week)

UNIT I

Electroanalytical Techniques
Introduction to coulometry, conductometry, anodic stripping voltammetry, TGA, DTA and online analyzers. Introduction to voltammetry, principle, instrumentation and its applications, 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 PropertiesClassification of materials: metal, semiconductor, insulator, band structures, Brillouin zones, mobility, resistivity.
Magnetic Properties: Super paramagnetism, 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

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Semester I

Paper VI

MCHE 106 Introduction to Analytical Techniques and Nanochemistry 30 hrs (2hrs/week)

Learning Outcomes:

Students will be able to:

- develop critical thinking for interpreting data using analytical techniques viz. coulometry , conductometry, annodic stripping voltammetry, TGA, DTA and chromatography.
- synthesize and characterize nanomaterials using, 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

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Semester I

Practical Scheme

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

MCHE 151 **Inorganic Chemistry**

Duration : 6 hours **Max. Marks: 60**

1. Analysis of mixture containing eight radicals including one rare element	24 marks
2. 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
3. Viva Voce	10 marks
4. Record	10 marks

MCHE 152 **Physical Chemistry**

Duration 6 hours **Max. Marks: 60**

1. Experiment No.1	20 marks
2. Experiment No.2	20 marks
3. Viva Voce	10 marks
4. Record	10 marks

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Semester I

MCHE: 151 **Inorganic Chemistry Practical** **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) Insoluble- 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.

(a) $K_3[Fe(C_2O_4)_3]$
(b) $[Ni(NH_3)_6]Cl_2$
(c)$[Ni(DMG)_2]$
(d) $[Cu(NH_3)_4]SO_4$
(e) Prussian blue
(f) $[Co(NH_3)_6]$ $[Co(NO_2)_6]$

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

Learning Outcomes:

Students will be able to:

- facilitate laboratory training and skills necessary for scientific or technological research.
- demonstrate identification and qualitative- quantitative separation techniques of organic and inorganic compounds.

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Semester I

MCHE : 152 **Physical Chemistry Practical** **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. $PbSO_4$, $BaSO_4$, etc.)conductometrically.
2. Determination of the strength of strong and weak acids in a given mixture conductometrically.
3. Determination of the equivalent conductance of a strong electrolyte at several concentration and hence verify the Onsager equation and also find value of a and b in this equation
   i. $\lambda_C = \lambda° - (a\,\lambda° + b)\sqrt{c}$
4. Determination of the equivalent conductivity of an electrolyte at infinite dilution.
5. Determination of the dissociation constant of an acid at different dilutions.

Series of experiments on Phase Equilibria-:

1. Determination of congruent composition and temperature of a binary system (diphenylamine-benzophenone system)
2. Construction of phase diagram for three component system (chloroform-acetic acid-water).

Series of experiments on Spectrophotometry

1. Verify Beer`s law for the solution of potassium permanganate and determine the concentration ofthe 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

Learning Outcomes:

Students will be able to:

- familiarize with the principles underlying the concepts of physical chemistry by experimental measurements.
- appreciate the central role of chemistry in the society and use this as a tool for addressing social, economic and environmental problems.

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Semester I

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

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.

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MASTER OF SCIENCE
Chemistry

Semester II
Semester Scheme

Paper Code	Paper title	Course Category	Credit	Total contact hours per semester / per week		Maximum Marks	Minimum Marks	ESE in hrs	
								Theory	Practical
MCHE 201	Inorganic Chemistry	DSC	4	60	4	100	40	3	-
MCHE 202	Organic Chemistry	DSC	4	60	4	100	40	3	-
MCHE 203	Physical Chemistry	DSC	4	60	4	100	40	3	-
MCHE 204	Spectroscopy II	DSC	4	60	4	100	40	3	-
MCHE 205	Biophysical Chemistry	DSC	2	30	2	50	20	3	-
MCHE 206	Environmental Chemistry-I	DSC	2	30	2	50	20	3	-
MCHE 251	Organic Chemistry Practicals	DSCP	6	90	6	100	40		6
MCHE 252	Physical Chemistry Practicals	DSCP	6	90	6	100	40		6
			32			700			

The details of the courses with code and title assigned are given below.
DSC= Discipline Specific Core ESE = End Semester Examination DSCP = Discipline Specific Core Practical

Examination Scheme

S.No.	Paper	ESE	CIA	Total
	Theory	**70%**	**30%**	**100%**
	Practical	**60%**	**40%**	**100%**

Syllabus of each theory paper is divided into four units. Each theory paper is of 3 hours duration.
Each Practical /Lab work is of 6 hours duration.

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

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

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Semester II
Semester Scheme

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

Maximum marks for each practical is 100 which includes 60 marks for ESE and 40 marks for internal assessment.

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Semester II

Examination Scheme

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 is compulsory to attempt any seven questions)	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 = 56marks
	Total marks for End of Semester Examination	**70 marks**
	Internal Assessment	**30 marks**
	Total	**100 marks**

Paper V-VI

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

Part A	Comprises of eight short answer questions with two questions from each unit. (It is compulsory to attempt any seven questions)	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**

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MASTER OF SCIENCE
Chemistry

Semester II
Paper I

MCHE201 **Inorganic Chemistry** **60 Hours(4Hrs./Week)**

Unit I

Symmetry and Group Theory in Chemistry: Symmetry elements and symmetry operations, 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 C_{2v} and C_{3v} point group. Symmetry aspects of molecular vibrations of water molecule.

Unit II

Reaction Mechanism of Transition Metal Complexes: Energy profile of a reaction (transition state or activated complex) nucleophilic and electrophilic substitution reaction, factors responsible for including SN_1 and SN_2 reaction, lability and inertness of octahedral complexes according to VBT and 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

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

CONTD…

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

MASTER OF SCIENCE
Chemistry

Semester II
Paper I

MCHE201 **Inorganic Chemistry** **60 Hours(4Hrs./Week)**

Learning Outcomes:

Students will be able to:

- recognize symmetry in molecules and understand its role in chemistry.
- understand the compound from a molecular level to a crystal structure level.

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.

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

MASTER OF SCIENCE
Chemistry

Semester II
Paper II

MCHE 202 **Organic Chemistry** **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. Circular dichroism, Optical rotatory dispersion, 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: 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. Phase transfer catalysts, Crown ethers and cryptands. Merrifield resins.

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.

Semester II
Paper II

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

Learning Outcomes:

Students will be able to:

- investigate geometry of organic compounds and design structure, reactivity and stability of new compounds.
- implement different approaches of pericyclic reactions in designing new synthetic routes for stereospecific compounds.

Suggested Books:

1. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Jerry March, John Wiley andSonsAsia 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.

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MASTER OF SCIENCE
Chemistry
Semester II
Paper III

MCHE 203 **Physical Chemistry** **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. Applications 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 law and application to Helium), Fermi-Dirac statistics (Distribution law and applications 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), factors 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 dimensions of various chain structures**.**

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

MASTER OF SCIENCE
Chemistry

Semester II
Paper III

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

Learning Outcomes:

Students will be able to:

- illustrate and validate experimentally the concepts and theories of classical and statistical thermodynamics.
- analyze and interpret adsorption phenomenon in natural, physical, biological and chemical system & its industrial applications.

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.

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MASTER OF SCIENCE
Chemistry

Semester II
Paper IV

MCHE 204 **Spectroscopy II** **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.

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

MASTER OF SCIENCE
Chemistry

Semester II
Paper IV

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

Learning Outcomes:

Students will be able to:

- examine the absorption frequencies of major functional groups and compare the factors that govern electronic absorption and implement this knowledge to interpret UV-VIS, IR and P-NMR spectra of organic compounds.
- analyze and implement the knowledge in understanding reaction rates, chemical environment and dynamics of the molecule.

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.

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MASTER OF SCIENCE
Chemistry

Semester II
Paper V

MCHE 205 **Biophysical Chemistry** **30 Hrs (4 hrs/week)**

UnitI
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 rotationalmotions.

Learning Outcomes:

Students will be able to:

- illustrate the concept of bio energetics and employ how living organism acquire and transform energy in order to perform biological work, structure, hydrolysis and synthesis of ATP molecules.
- evaluate mechanism involved in biopolymer interactions to explain structure of cell membrane, its functions, active and passive transport mechanisms.

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 PressLtd., 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.

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MASTER OF SCIENCE
Chemistry

Semester II
Paper VI

MCHE 206 **Environmental Chemistry - I** **30 Hrs (4 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. Reactions 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 onaquatic life, plants, buildings and health. Monitoring of SO2 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 ofchemistry and meteorology, control strategies.Green House Effect:
Terrestrial and solar radiation spectra, major green house gases and their sources and global warming potentials. Climatechange and consequences.Urban Air Pollution:
Exhaust emissions, damaging effects of carbon monoxide, monitoring of CO and 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, 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.

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

MASTER OF SCIENCE
Chemistry

Semester II
Paper VI

MCHE 206 **Biophysical Chemistry** **30 Hrs (4 hrs/week)**

Learning Outcomes:
Students will be able to:

- apply knowledge of Chemistry to find the most suitable measures, management methods and industrial solutions to ensure a sustainable use of the earth's resources and ecosystem services
- identify and understand mechanistic pathways for tropospheric cycles.

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

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Semester II

Practical Scheme

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

MCHE 251 **Organic Chemistry**

Duration 6 hours **Max. Marks: 60**

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

MCHE 252 **Physical Chemistry**

Duration 6 hours **Max. Marks: 60**

Two physical experiments from the prescribed syllabus of 20 marks each (2)	40 marks
Record	10 marks
Viva	10 marks

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Chemistry

Semester II

MCHE 251 **Organic Chemistry Practical** **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.

Learning Outcomes:
Students will be able to:

- perform laboratory work using standard safety procedures and interpret the results of the experiment.
- solve quantitative chemistry problems and device synthetic approaches to relatively simple organic compounds using the one and two step synthesis

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Chemistry

Semester II

MCHE252 **Physical Chemistry Practical** **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 S2O8 2- and the rate constant for the uncatalyzed reaction.
4. Determine the energy of activation and entropy of activation for the reaction. $2MnO_4^- + 5C_6H_5CH_2OH + 6\,H^+ \rightarrow 2Mn^{2+} + 5C_6H_5CHO + 8H_2O$

Series of Experiments on Potentiometry / pH metry

1. Determination of strength of halides in a mixture potentiometrically.
2. Determination of strength of strong and weak acids in a given mixture using a potentiometer / pH meter.
3. Determination of temperature dependence of EMF of a cell.
4. Determination of formation constant of silver – ammonia complex and stoichiometry of the complexpotentiometrically.
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 ofclassical adsorption isotherm
2. To investigate the adsorption of acetic acid from aqueous solution by activated charcoal and examine validity ofclassical adsorption isotherm.

Learning Outcomes:

Students will be able to:

- expertize in problem solving, critical thinking and analytical reasoning as applied to natural and scientific phenomenon.
- anlyze and apply chemical kinetics , potentiometry, pH metry and adsorption phenomenon in real life problems.

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Chemistry

Semester II

MCHE 252 **Physical Chemistry Practical** **90 hrs (6 hrs/week)**

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.

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MASTER OF SCIENCE
Chemistry

Semester III
Semester Scheme

Paper Code	Paper title	Course Category	Credit	Total contact hours per semester / per week		Maximum Marks	Minimum Marks	ESE in hrs	
								Theory	Practical
MCHE 301	Photochemistry	DSC	4	60	4	100	40	3	-
MCHE 302	Bioorganic Chemistry	DSC	2	30	2	50	20	3	-
MCHE 303	Environmental Chemistry II	DSC	2	30	2	50	20	3	-
Group A : Elective Papers: Organic Chemistry									
MCHE 304A	Organic Synthesis-I	DSE	4	60	4	100	40	3	-
MCHE 305A	Natural Products-I	DSE	4	60	4	100	40	3	-
MCHE 306A	Heterocyclic Chemistry-I	DSE	4	60	4	100	40	3	
MCHE 351	Inorganic Chemistry Practicals	DSEP	6	90	6	100	40	-	6
MCHE 352	Organic Chemistry Practicals	DSEP	6	90	6	100	40	-	6
			32			700			
Group B: Elective Papers: Physical Chemistry									
MCHE 314	Advanced Electrochemistry-I	DSE	4	60	4	100	40	3	-
MCHE 315	Phase Rule and Surface Phenomenon	DSE	4	60	4	100	40	3	-
MCHE 316	Advanced Chemical Kinetics-I	DSE	4	60	4	100	40	3	
MCHE 361	Inorganic Chemistry Practical	DSEP	6	90	6	100	40	-	6
MCHE 362	Physical Chemistry Practical	DSEP	6	90	6	100	40	-	6
			32			700			

The details of the courses with code and title assigned are given below.
DSC= Discipline Specific Core ESE = End Semester Examination DSCP = Discipline Specific Core Practical

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Chemistry

Semester III
Semester Scheme

Note: Student has to take prior permission by the Head of the Department for the online Certificate Course on Swayam /MOOCs/ Coursera.

Note: First three papers are compuisory and Students will choose any one elective Group A* (Specialization: Organic Chemistry) or B* (Specialization: Physical Chemistry).

Examination Scheme

S.No.	Paper	ESE	CIA	Total
	Theory	**70%**	**30%**	**100%**
	Practical	**60%**	**40%**	**100%**

Syllabus of each theory paper is divided into four units. Each theory paper is of 3 hours duration Each Practical /Lab work 6 hours duration.

The number of papers and the maximum marks for each paper/ practical is 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- VI) is 100 which include 70 marks for ESE and 30 marks for internal assessment.
Maximum marks for a theory paper (II-III) is 50 which include 35 marks for ESE and 15 marks for internal assessment.

Maximum marks for each practical is 100 which includes 60 marks for ESE and 40 marks for internal assessment.

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Semester III
Examination Scheme
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 is compulsory to attempt any seven question)	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 = 56marks
	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 is compulsory to attempt any seven question)	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**

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Semester III

Paper II

MCHE301 **Photochemistry** **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 mechanism : 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 and 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 and Aromatics

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

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.

Learning Outcomes:

Students will be able to:

- design the mechanisms of natural photochemical processes viz. synthesis of vitamin D in skin , ozone formation in atmosphere, action of enzymes, etc.
- interprate and distinguish between photochemical and photophysical processes using Jablonskii diagram and their quantum yield expressions.

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
Chemistry

Semester III

Paper II

MCHE302 **Bioorganic Chemistry** **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 & key hypothesis 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, structureand 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, applications 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.

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

MASTER OF SCIENCE
Chemistry

Semester III

Paper II

MCHE302 **Bioorganic Chemistry** **30 hrs (2 hrs/week)**

Learning Outcomes:

Students will be able to:

- illustrate and create novel enzyme models and evaluate their role in biological systems.
- implement knowledge of biotechnological applications of enzymes in day to day life.

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.

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

MASTER OF SCIENCE
Chemistry

Semester III

Paper III

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

Unit I

Environmental Toxicology

Toxic Heavy Metals: Mercury, Lead Arsenic and Cadmium, causes of toxicity, bioaccumulation, sources of heavy metals, chemical speciation of Hg, Pb, As and Cd, biochemical and damaging effects; Toxic Organic Compounds: Pesticides, classification, properties and uses of organochlorine and ionospheres pesticides, detection and damaging effects; Polychlorinated Biphenyls: Properties, use and environmental continuation and effects; Polynuclear Aromatic Hydrocarbons**:** Sources, structures and role as pollutants.

Unit II

Soil and Environmental Disasters

Soil composition, micro and macronutrients, soil pollution by fertilizers, plastic and metals. Methods of re-mediation of soil. Bhopal gas tragedy, Chernobyl disaster, Three Mile Island, Minamata disease, Seveso disaster (Italy), London smog.

Unit III

Waste Management

Waste classification, solid waste disposal and waste management, land filling, incineration, dioxins, medical waste, electronic waste, paper waste, sources of water pollution, treatment of waste and sewage, techniques of purification and disinfection.

Unit IV

Natural Resources, 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 energy resources- consumption and conservation: Environmental management.

Learning Outcomes:

Students will be able to:

- acquire knowledge for the sustainable use of resources.
- create models of advanced analytical tools to predict consequences of the environmental challenges.

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
Chemistry

Group A: Organic Chemistry

Semester III

Paper IV

MCHE 304 **Organic Synthesis-I** **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)

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

MASTER OF SCIENCE
Chemistry

Group A: Organic Chemistry

Semester III

Paper IV

MCHE 304 **Organic Synthesis-I** **60 hrs (4 hrs/week)**

Learning Outcomes:

Students will be able to:

- design the novel synthesis processes to organic compounds,drugs, etc.using enolate chemistry.
- enumerate and apply metallic and non metallic oxidising and reducing reagent in organic synthesis.

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
Chemistry

Group A: Organic Chemistry

Semester III

Paper V

MCHE 305 **Natural Products-I** **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.

Learning Outcomes:

Students will be able to:

- have basic knowledge of natural sources and implement isolation and structure illucidation techniques for natural products.
- predict the path for characterization and synthesis of naturally occuring organic compounds.

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MASTER OF SCIENCE
Chemistry

Group A: Organic Chemistry

Semester III

Paper V

MCHE 305 **Natural Products-I** **60 hrs (4 hrs/week)**

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 publishinghouse.
5. Chemistry, Biological and Pharmacological properties of medicinal plants from the Americas, Ed. KurtHostettmann,M.P. gupta and A. Martson, Harwood Academic publishers.

MASTER OF SCIENCE
Chemistry

Group A: Organic Chemistry

Semester III

Paper VI

MCHE 306 **Heterocyclic Chemistry - I** **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 Heterocycles

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

Learning Outcomes:

Students will be able to:

- compose the nomenclature, structure, synthesis, physical properties and chemical reactions of heterocyclic compounds.
- identify and deduce organic chemistry problems and explore new areas of research.

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MASTER OF SCIENCE
Chemistry

Group A: Organic Chemistry

Semester III

Paper VI

MCHE 306 **Heterocyclic Chemistry - I** **60 hrs (4 hrs/week)**

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 Wileyand Sons, New Delhi, 1976.
5. Contemporary Heterocyclic Chemistry; G.R. Newkome and W.W. Paudler; Wiley Interscience.

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MASTER OF SCIENCE
Chemistry

Group A: Organic Chemistry

Semester III

Practical Scheme

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

MCHE 351 **Inorganic Chemistry**

Duration 6 hours **Max. Marks: 60**

1. Separation and determination of two metal ions involvingvolumetric and gravimetric methods — 25 marks

OR

Paper chromatographic separation of two metal ions and determination of Rf value.

2. Preparation of one selected inorganic compound and its study by IR — 15marks
3. Viva Voce — 10 marks
4. Record — 10 marks

MCHE 352 **Organic Chemistry**

Duration 6 hours **Max. Marks: 60**

1. Separation, purification and identification of compounds of binary mixture {(one liquid and one solid) or (twosolids)} using chemical test and form their derivatives — 22marks

OR

Extraction of organic compounds from natural resources

2. Preparation of one selected organic compound — 18marks
3. Viva Voce — 10 marks
4. Record — 10 marks

MASTER OF SCIENCE
Chemistry

Group A: Organic Chemistry

Semester III

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

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

Chromatographic separation

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

Preparation

Preparation of selected inorganic compounds and their studies by I.R. spectra, Mössbauer, E.S.R and magneticsusceptibility 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

Learning Outcomes:

Students will be able to:

- expertise in quantitative analysis of metal ions using volumetric, gravimetric and chromatographic methods.
- design and carry out organic synthesis and implement skill in new areas of research in both chemistry and allied fields of science and technology.

MASTER OF SCIENCE
Chemistry

Group A: Organic Chemistry

Semester III

MCHE 352 **Organic Chemistry Practical** **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 tests and prepare their derivatives

Multistep Organic Synthesis

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

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.

Learning Outcomes:

Students will be able to:

- analyze and investigate qualitatively binary mixture of organic compounds and prepare their derivatives.
- construct a new pathway for organic synthesis and apply different purification techniques .

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MASTER OF SCIENCE
Chemistry

Group A: Organic Chemistry

Semester III

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

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; JohnWiley and Sons, Inc., New York, 1997.

MASTER OF SCIENCE
Chemistry

Group B: Physical Chemistry

Semester III

Paper IV

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

Unit-I

Electroanalytical Techniques

Electrogravimetry ,electrodes of the first kind,electrodes of the second kind,inert redox electrode ,electrolytic cell, galvanostat and potentiostat, theory and principle of electrogravimetry,types of electrogravimetry, concept of decomposition potential,ohmic potential ,electrolysis at constant current ,electrolysis at constant voltage and at controlled potential ,spontaneous or internal electrolysis**.**

Electrochemical Generators (Fuel Cells): Hydrogen-oxygen cells, hydrogen Air cell, hydrocarbon air cell, alkaline fuel cell, phosphoric fuel cell, direct MeOH 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: (i) 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 (Pourbaix diagrams). Advantages and disadvantages, 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.

CONTD…

MASTER OF SCIENCE
Chemistry

Group B: Physical Chemistry

Semester III

Paper IV

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

Learning Outcomes:

Students will be able to:

- develop the test methods for measurement and monitoring of corrosion.
- demonstrate the systematic approach in reinforcing various types of fuel cells.

Books suggested:

1. Modern Electrochemistry vol. I, IIA Vol. IIB, J'OM Bochris and A.K.N. Reddy, Plenum Publication, New York.
2.Analytical Chemistry Second edition D.C .Dash PHI Learning Private limited.2017
3. Modern Polarographic Methods by A.M. Bond, Marcell Dekker.

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MASTER OF SCIENCE
Chemistry

Group A: Physical Chemistry

Semester III

Paper V

MCHE 315 **Phase Rule and Surface Phenomenon** **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 rule, 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. Applications 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.

MASTER OF SCIENCE
Chemistry

CONTD…..

Group B: Physical Chemistry

Semester III

Paper V

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

Learning Outcomes:

Students will be able to:

- have an idea about the different phases of matter and their equilibria from which the stability and sustainability can be easily predicted
- demonstrate the applications of colloidal and surface chemistry in industries and environment.

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
Chemistry

Group B: Physical Chemistry

Semester III

Paper VI

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

Unit-I

Induced and Kinetic Phenomenon

Induced Phenomena: Induced reactions, kinetics of Induced reactions and their characteristics. Induction factor and its mechanistic significance.

Kinetic Phenomenon: Steady state approximation ,reversible or opposing reactions, consecutive reactions ,parallel reactions, side reactions or opposing reactions ,competing reactions and their mechanism, Frank-Robinovich effect or Cage effect , Wegscheider s Test for side reactions and its applications ,surface reactions.

Unit-II

Kinetics and Mechanism of reactions

Kinetics and Mechanism of some reactions: (i) Reactions where first step is a rate -determining step (ii) Reactions in which the first step of the mechanism is a first equilibrium which gives rise to an intermediate and the latter thus reacts slowly in rate -determining step (iii) Reactions involving more than two elementary processes with at least one slow step (iv) Reactions where all the steps have comparable rate.

Unit-III

Oscillatory Reactions

Autocatalysis and oscillatory reactions, thermodynamic 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 reactions and acid catalyzed reactions. Auto-oxidations, upper and lower explosion limits, thermal para-ortho Hydrogen conversion, Rice-Herzfield mechanisms.

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.

Kinetics in Liquid Solutions

Comparison between gas phase and solution reactions, solvent effects on reaction rates, experimental study of reactions in solutions, factors affecting reaction rates in solution, collisions in solution, Theory of absolute reaction rates applicable to reactions in solution, diffusion, Ficks law of diffusion (First and second law) ,elementary reactions in solution .

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MASTER OF SCIENCE
Chemistry

Group B: Physical Chemistry

Semester III

Paper VI

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

Learning Outcomes:

Students will be able to:

- have detailed knowledge about induced and kinetic phenomenaan.
- able to get acquainted with various types of reaction mechanism and kinetics, also updated with Oscillatory Reactions and Electron Transfer Reactions in Metal Complexes,

Suggested Books

1. Chemical Kinetics and Reaction Dynamics Paul Houston Mc Graw Hill 2001
2. R. Lumry and R.W. Raymond, Electron transfer reaction, inter-science publication,1997.
3. Introduction to Molecular Dynamics and Chemical Kinetics and Advanced Molecular Dynamics and Chemical Kinetics 2 Volume Set .Gert Due Billing ,Kurt V. Mikkelsen Wiley Publication .1997
4. Chemical Kinetics -3rd Edition -Keith J.LaIdler 1987.Pearson Education
5. H. Taube, Electron transfer reactions in solution, Academic Press, London,1970

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MASTER OF SCIENCE
Chemistry

Group B: Physical Chemistry

Semester III

Practical Scheme

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

MCHE 361 **Inorganic Chemistry**

Duration 6 hours **Max. Marks: 60**

1. Separation and determination of two metal ions involving volumetric and gravimetric methods — 25 marks

OR

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

2. Preparation of one selected inorganic compound and its study by IR — 15 marks
3. Viva Voce — 10 marks
4. Record — 10 marks

MCHE 362 **Physical Chemistry**

Duration 6 hours **Max. Marks: 60**

1. Phase equilibrium — 22 marks
2. Chemical Kinetics — 18 marks

OR

Liquid and Colloidal State

3. Viva Voce — 10 marks
4. Record — 10 marks

MASTER OF SCIENCE
Chemistry

Group B: Physical Chemistry

Semester III

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

Quantitative analysis: Separation and determination of two metal ions Cu-Ni, Ni-Zn, Cu-Fe etc. involvingvolumetric 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 magneticsusceptibility 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

Learning Outcomes:

Students will be able to:

- expertise in quantitative analysis of metal ions using volumetric, gravimetric and chromatographic methods.
- design and carry out organic synthesis and implement skill in new areas of research in both chemistry and allied fields of science and technology.

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Group B: Physical Specialization

Semester III

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

(A) Phase Equillibrium

1. Determination of the freezing point depression constant of camphor using naphthalene as solute. Hencedetermine 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 Construct the mutual solubility curve of phenol + H_2O, and hence the upper consolute point.
4. Determination of the distribution coefficient of I_2 between CCl_4 and H_2O.
5. Find the molecular weight of given liquid by steam distillation method.
6. 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 reactionmeasuring 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 itsdecomposition.
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 theunanalysed reaction .

(C) Liquid and Colloidal State

1. Preparation of Arsenious sulphide / Ferric hydroxide sols and study Hardy – Schulze's rule.
2. Determination of the coefficient of viscosity of given liquid by Ostwald's viscometer.
3. Determination of molecular weight of polymer by viscosity measurements,
4. Determination of surface tension ofgiven liquid by drop no. method by stalagmometer.

Learning Outcomes:

Students will be able to:

- analyze the molecular weight, upper consolute point and distribution coefficient by phase equilibrium.
- evaluate Hardy – Schulze's rule for arsenious sulphide / Ferric hydroxide sols.

Suggested Books:

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

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Semester IV

Semester Scheme

Paper Code	Paper title	Course Category	Credit	Total contact hours per semester / per week		Maximum Marks	Minimum Marks	ESE in hrs	
								Theory	Practical
Group A : Elective Papers : Organic Chemistry									
MCHE 401	Green Chemistry	DSE	4	60	4	100	40	3	-
MCHE 402	Organic Synthesis-II	DSE	4	60	4	100	40	3	-
MCHE 403	Medicinal Chemistry and Natural Products-II	DSE	4	60	4	100	40	3	-
MCHE 404	Heterocyclic Chemistry-II	DSE	4	60	4	100	40	3	-
MCHE 451	Inorganic Practicals	DSEP	6	90	6	100	40	-	6
MCHE 452	Organic Practicals	DSEP	6	90	6	100	40	-	6
MCHE 453	Seminar Project	-	4			100	40	-	-
			32			700		-	-
Group B: Elective Papers : Physical Chemistry									
MCHE 411	Nanochemistry and Nanocatalysis	DSE	4	60	4	100	40	3	-
MCHE 412	PolymerChemistry	DSE	4	60	4	100	40	3	-
MCHE 413	Chemistry ofMaterials	DSE	4	60	4	100	40	3	-
MCHE 414	Advanced Electrochemistry -II	DSE	4	60	4	100	40	3	-
MCHE 461	Inorganic Practical	DSEP	6	90	6	100	40	-	6
MCHE 462	Physical Practical	DSEP	6	90	6	100	40	-	6
MCHE 463	Seminar Project	-	4			100	40	-	-
			32			700		-	-

The details of the courses with code and title assigned are given below.
DSE= Discipline Specific Elective ESE = End Semester Examination DSEP = Discipline Specific Elective Practical

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Semester Scheme

Note: Certificate Course on Swayam /MOOCs/ Coursera of three Months.
Student has to take prior permission by the Head of the Department for the online Certificate Course on Swayam /MOOCs/ Coursera .

Examination Scheme

S.No.	Paper	ESE	CIA	Total
	Theory	**70%**	**30%**	**100%**
	Practical	**60%**	**40%**	**100%**

Syllabus of each theory paper is divided into four units. Each theory paper is of 3 hours duration .
Each Practical /Lab work is of 6 hours duration.

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

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

Maximum marks for Seminar Presentation is 100 .

Maximum marks for each practical is 100 which includes 60 marks for ESE and 40 marks for internal assessment.

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Chemistry

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Examination Scheme

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 is compulsory to attempt any seven questions)	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 = 56marks
	Total marks for End Semester Examination	**70 marks**
	Internal Assessment	**30 marks**
	Total	**100 marks**

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Chemistry

Group A : Organic Chemistry

Semester IV

Paper I

MCHE 401 **Green Chemistry** **60 hrs (4 hrs/week)**

Unit I

Introduction, Principle and Concepts of Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Inception and evolution of Green Chemistry. Twelve principles of Green Chemistry with their explanations and examples. Designing a green synthesis using these principles, Green chemistry in day to day life.

Unit II

Non-Traditional Greener Alternative Approaches

Different approaches to green synthesis (a) Uses of green reagents in green synthesis- dimetyl carbonate, polymer supported reagents- peracids and chromic acids. (b) Green catalysis, oxidation catalysts, basic catalysts and polymer supported catalysts. (c) Phase transfer catalysts in green synthesis, advantages of PTC reactions to green synthesis, applications of PTCs in N/C- alkylation, Darzen's reaction, Wittig reaction, heterocyclic compounds: 3-alkyl coumarins, 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

Applications 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 and quinoline.

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

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MASTER OF SCIENCE
Chemistry

Group A : Organic **Chemistry**

Semester IV

Paper I

MCHE 401 **Green Chemistry** **60 hrs (4 hrs/week)**

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) Applications 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.

Learning Outcomes:

Students will be able to:

- design and implement cleaner production of suitable energy efficient processes.
- realise the importance of green technologies in sustainable growth of industries and society.

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 , NarosaPublishing 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 , NarosaPublishing House ,2006

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Group A : Organic Chemistry

Semester IV

Paper II

MCHE 402 **Organic Synthesis- II** **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, usesof 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.

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Chemistry

Group A : Organic Chemistry

Semester IV

Paper II

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

Learning Outcomes:

Students will be able to:

- understand the synthesis, reactivity and importance of systems like 3-membered, 4-membered and 5- membered rings.
- familiarize with carbonyl condensation, Diels Alder reaction and 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; JohnWiley 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; KluwerAcademic/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.

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Group A : Organic Chemistry

Semester IV

Paper III

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

Unit I
Porphyrins
Structure elucidation and synthesis of Haemoglobin and Chlorophyll.
Prostaglandin
Occurrence, nomenclature, classification, biogenesis and physiological effects.

Unit II
Vitamins
Introduction, synthesis, biological function and deficiency syndromes of vitamin B (Thiamine), E, C and K.
Pyrethroids
Introduction, structure elucidation and synthesis of pyrethroids namely pyrethrines and cinerins. Structure activityrelationship 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, structuredetermination 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 and CCNU). New developments like gene therapy and drug resistance.

Learning Outcomes:

Students will be able to:

- understand nomenclature, classification and structure elucidation of haemoglobin, chlorophyll and prostglandins .
- explore the biological activity of steroids and the mode of action of different chemotherapeutic agents (anti-histamines,analgesics, antimalarial and anti-viral drugs etc.)

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Group A : Organic Chemistry

Semester IV

Paper III

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

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 publishinghouse.
5. Chemistry, Biological and Pharmacological properties of medicinal plants from the Americas, Ed. Kurthostettmann, M.P. gupta and A. Martson, Harwood Academic publishers.

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Group A : Organic Chemistry

Semester IV

Paper IV

MCHE 404 **Heterocyclic Chemistry II** **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.

Learning Outcomes:

Students will be able to:

- gain knowledge about the structure, synthesis, reactions and properties of the major classes of heterocyclic compounds.
- plan the synthesis of new heterocylic compounds according to the required pharmacological activity.

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Group A : Organic Chemistry

Semester IV

Paper IV

MCHE 404 **Heterocyclic Chemistry II** **60 hrs (4 hrs/week)**

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; JohnWiley and Sons, New Delhi, 1976.
5. Contemporary Heterocyclic Chemistry; G.R. Newkome and W.W. Paudler; Wiley Interscience.

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Group A : Organic Chemistry

Semester IV

Practical Scheme

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

MCHE 451 **Inorganic Chemistry**

Duration 6 hours **Max. Marks: 60**

1. Spectrophotometric determination 25 marks
2. Flame photometric determination or

OR

Volumetric determination 15 marks

3. Viva Voce 10 marks
4. Record 10 marks

MCHE 452 **Organic Chemistry**

Duration 6 hours **Max. Marks: 60**

1. 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 tests and prepare their derivatives. 25 marks
2. Identification of organic compounds by the analysis of their spectral data 15 marks

OR

Spectrophotometric determination

3. Viva Voce 10 marks
4. Record 10 marks

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Semester IV

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

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Group A : Organic Chemistry

Semester IV

MCHE 451 **Inorganic Chemistry** **90Hrs (6hrs/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.

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Group A : Organic Chemistry

Semester IV

MCHE 452 **Organic Chemistry** **90Hrs (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.

Learning Outcomes:

Students will be able to:

- analyze mixture of three organic compounds and use various techniques like TLC, IR, PMR for their purity check and chemical analysis.
- do spectrophotometric estimations of biomolecules.

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.

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Group B : Physical Chemistry

Semester IV

Paper I

MCHE 411 **Nanochemistry andNanocatalysis** **60 hrs (4 hrs/week)**

Unit 1

Basic Concepts of Nanochemistry

Introduction to nanoscience and nanotechnology, discussion on various phenomena at nanoscale such as size, shape, surface, surface energy, surface stabilization, characteristic length, self-assembly, defects, size quantization, surface plasmon, conductivity and 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, electro depostion, 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 Nanostructure

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, applications 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.

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Group B : Physical Chemistry

Semester IV

Paper I

MCHE 411 **Nanochemistry and Nanocatalysis** **60 hrs (4 hrs/week)**

Learning Outcomes:

Students will be able to:

- understand the synthesis of nanomaterials, their applications and the impact on environment.
- categorize and identify the different types of Nanomaterials for catalysis.

Suggested books:

1. Understanding Nanomaterials -Malkiat.s .Johal ,Lewis E Johnson CRC Press Taylor and FrancisLondon 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 McGrawHill, 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.

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Group B : Physical Chemistry

Semester IV

Paper II

MCHE 412 **Polymer Chemistry** **60 hrs (4 hrs/week)**

Unit I
Basics of Polymers
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.

Learning Outcomes:

Students will be able to:

- understand the study of methods of polymerization reactions and their properties, advantages, disadvantages, modifications and applications.
- develop specific skills, competencies, and thought processes sufficient to support further study or work in this field of Polymer Chemistry.

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Group B : Physical Chemistry

Semester IV

Paper II

MCHE 412 **Polymer Chemistry** **60 hrs (4 hrs/week)**

Suggested books

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

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Group B : Physical Chemistry

Semester IV

Paper III

MCHE 413 **Chemistry of Materials** **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 superconductor (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, elastic 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 techniques, photolithography, properties and applications of thin and LB films.

Unit IV

Glasses, Ceramics, Refractories and composites

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

Learning Outcomes:

Students will be able to:

- provide intellectual foundation to design, create understand new forms of matter.
- aquire knowledge for the preparation of range of materials such as glass, plastic and liquid crystals.

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Group A : Physical Chemistry **Semester IV**

Paper III

MCHE 413 **Chemistry of Materials** **60 hrs (4 hrs/week)**

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

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Group A : Physical Chemistry

Semester IV

Paper IV

MCHE 414 **Advanced Electrochemistry-II** **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 waves. Methods of determining kinetic parameters for quasi-reversible and irreversible waves: Koutecky's method. Meites 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, reactions involving adsorbed species, Influence of various parameters.

Unit-III

Bulk Electrolysis Method

Controlled potential coulometry, controlled coulometry, Electroorganic synthesis and its importance, applications, stripping analysis, anodic and cathodic modes, pre electrolysis and stripping steps, applications of stripping analysis.

Unit-IV

Electrocrystallization: Electrogrowth 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**.**

Learning Outcomes:

Students will be able to:

- to acquaint with the advanced aspects of electrochemistry as to understand the mechanism and processes by advanced Electrolysis Methods
- apply the acquired knowledge to various electrochemical aspects for social benefits.

CONTD…

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

MASTER OF SCIENCE
Chemistry

Group B : Physical Chemistry

Semester IV

Paper IV

MCHE 414 **Advanced Electrochemistry-II** **60 hrs (4 hrs/week)**

Suggested books:

1. Modern Electrochemistry vol. I,IIA Vol. IIB, J'OM Bochris and A.K.N. Reddy, Plenum Publication, NewYork.
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 ,EngineeringBiology and Environmental Science 2 nd Ed. Springer (2001)

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

MASTER OF SCIENCE
Chemistry

Group B : Physical Chemistry

Semester IV

Practical Scheme

Note: Total marks for each semester practical is 100, which includes 60 marks for ESE and 40 marks for internalassessment.

MCHE 461 **Inorganic Chemistry**

Duration 6 hours **Max. Marks: 60**

1. Spectrophotometric determination	25 marks
2. Flame photometric determination or	
OR	
Volumetric determination	15 marks
3. Viva Voce	10 marks
4. Record	10 marks

MCHE 462 **Physical Chemistry**

Duration 6 hours **Max. Marks: 60**

1. Electrochemistry or Spectrophotometry	25 marks
2. Coulometric Titrations	
OR	
Conductometry	15 marks
3. Viva Voce	10 marks
4. Record	10 marks

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

MASTER OF SCIENCE
Chemistry

Group B : Physical Chemistry

Semester IV

MCHE 463	**Seminar\Project**	**Max. marks: 100**
Submission of hard and soft copy		50 marks
Presentation		30 marks
Viva		20 marks

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MASTER OF SCIENCE
Chemistry

Group B : Physical Chemistry

Semester IV

MCHE 461 **Inorganic Chemistry Practical** **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)

a) Determination of Chloride ion in water by Mohr's method or by use of adsorption indicator.
b) Analysis of Talcum powder by EDTA titration.
c) Analysis of hydrogen peroxide by Iodometric method.
d) Determination of percentage purity of Boric acid
e) 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.

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MASTER OF SCIENCE
Chemistry

Group B : Physical Chemistry

Semester IV

MCHE 462 **Physical Chemistry Practical** **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, plotting equivalent conductivity ($\sqrt{c}$) and obtaining the slope of the straight line passing through the origin. Slope is equal to $\Lambda a \sqrt{k}$.
3. To determine the equivalent conductance of the strong electrolytes (KCl, NaCl, HNO_3, HCl etc.) at several concentrations and verify Osanger equation.
   $Av=A\infty-(AA\infty+B)\sqrt{c}$. 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

Suggested Books:

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

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Chemistry
