VIVEKANANDCOLLEGE, KOLHAPUR

(EMPOWERED AUTONOMOUS)

DEPARTMENT OF CHEMISTRY

Two Years PG Programme

Department/Subject Specific Core or Major (DSC)

Curriculum, Teaching and Evaluation Structure

for

M. Sc. I Chemistry

Semester: I & II

(Implemented from academic year 2023-24 onwards)

VIVEKANAND COLLEGE, KOLHAPUR
(EMPOWERED AUTONOMOUS)
DEPARTMENT OF CHEMISTRY
Syllabus for the Master of Science in Chemistry
M. Sc. I (Sem. I & II)
(National Education Policy 2020)
Applicable From Academic Year: 2023 – 2024

1. **Title**: M. Sc. Chemistry, Vivekanand College, Kolhapur (Autonomous)
2. **Faculty**: Faculty of Science and Technology.
3. **Year of Implementation**: For M. Sc. I (Semester I and Semester II): From July 2023 and for M. Sc. II (Semester III and Semester IV): From July 2024.
4. **Programme Outcomes (POs):** After completing the M. Sc. Programme, the students will able to:

   PO1: Demonstrate and apply the fundamental knowledge of the basic principles of sciences in variousfields.

   PO2: Create awareness and a sense of responsibility towards the environment and society to solve the issues related to environmental pollution.

   PO3: Apply their professional, social, and personal knowledge.

   PO3: Competent to pursue research or pursue a career in the subject.

   PO4: Apply knowledge to build up small-scaleindustries for developing endogenous products.

   PO5: Communicate scientific information in a clear and concise manner both orally and in writing.

   PO6: Inculcate logical thinking to address a problem and become result oriented with a positive attitude.

5. **Programme Specific Outcomes (PSOs):** After completing the M. Sc. Programme in Chemistry, the students will able to:

   PSO1: Demonstrate, solve, and understand major concepts in all disciplines of chemistry.

   PSO2: Think methodically, and independently, and draw a logical conclusion of chemistry.

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PSO3: Employ critical thinking and scientific knowledge to design, carry out, record, and analyze the results of chemical reactions.

PSO4: Create an awareness of the impact of chemistry on the environment, society, and development outside the scientific community.

PSO5: To inculcate the scientific temperament in the students and outside the scientific community.

PSO6: Use modern techniques, decent equipment, and various chemistry software.

Teaching and Evaluation Scheme

DEPARTMENT OF CHEMISTRY

M. Sc. I (Sem. I & II) From Academic Year: 2023 – 2024

Sr. No.	Course Abbr.	Course code	Course Name	Teaching Scheme Hours/week		Examination Scheme and Marks				Course Credits
				TH	PR	ESE	CIE	PR	Marks	
Semester-I										
1	DSC-I	DSC14CHE11	Inorganic & Organic Chemistry	4	-	80	20	-	100	4
2	DSC-II	DSC14CHE12	Physical & Analytical Chemistry	4	-	80	20	-	100	4
3	DSE-I	DSE14CHE11	Inorganic Chemistry	4	-	80	20	-	100	4
4	DSE-II	DSE14CHE12	Organic Chemistry	4	-	80	20	-	100	4
5	DSE-III	DSE14CHE13	Physical Chemistry	4	-	80	20	-	100	4
6	DSE-IV	DSE14CHE14	Analytical Chemistry	4	-	80	20	-	100	4
7	RMD-I	RMD14CHE11	Research Methodology	4	-	80	20	-	100	4
8	DSC-PR-I	DSC03CHE19	Chemistry Lab-1	-	4		-	100	100	4
9	MIN-PR-II	MIN03CHE19	Chemistry Lab-II	-	2		-	50	50	2
				16	**06**	**320**	**80**	**150**	**550**	**22**
Semester-II										
1	DSC-III	DSC14CHE21	Inorganic & Organic Chemistry	4	-	80	20	-	100	4
2	DSC-IV	DSC14CHE22	Physical & Analytical Chemistry	4	-	80	20	-	100	4
3	DSE-V	DSE14CHE21	Inorganic Chemistry	4	-	80	20	-	100	4
4	DSE-VI	DSE14CHE22	Organic Chemistry	4	-	80	20	-	100	4
5	DSE-VII	DSE14CHE23	Physical Chemistry	4	-	80	20	-	100	4
6	DSE-VIII	DSE14CHE24	Analytical Chemistry	4	-	80	20	-	100	4
1	DSC-PR-III	DSC03CHE29	Chemistry Lab-III	-	4	-	-	100	100	4
2	MIN-PR-IV	MIN03CHE29	Chemistry Lab-IV	-	2	-	-	50	50	2
				12	**06**	**320**	**80**	**150**	**550**	**22**
7	OJT-I	OJT14CHE21	On Job Training		04	-	-	-	100	4
	Total (Sem. I & II)			**28**	**16**	**640**	**160**	**300**	**1100**	**44**

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M. Sc. Chemistry Part – I: Semester – I
CH.101: DSC-I: Major Paper: Inorganic & Organic Chemistry
(DSC14CHE11)

Course Outcomes: After the completion of the course, the student will be able to:

CO1 Learn transition elements and the role of various metals and non metals in our health.

CO2 Impart essential knowledge regarding the characteristics, properties, applications, and separation of lanthanides and actinides.

CO3 Identify different types of chirality, stereoisomerism, and concept involved in stereoisomers.

CO4 Adopt the types of reactions, transition states and intermediates, Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes, and nitrenes and the effect of structure on reactivity.

Section I: Inorganic Chemistry

UNIT-I

(A) Chemistry of Transition Elements **[10]**

General characteristics and properties of transition elements, coordination chemistry of transition metal ions, the stereochemistry of coordination compounds, crystal field theory, crystal field splitting of d orbitals for octahedral, tetrahedral, square planar, and square pyramidal complexes, crystal field stabilization energy (CFSE), factors affecting the crystal field parameters, strong and weak field complexes, spectrochemical series, Jahn - Teller effect, Interpretation of electronic spectra through d-d spectra and charge transfer spectra, nephelauxetic series.

(B) Bioinorganic Chemistry **[05]**

Role of metal ions in biological processes, structure and properties of metalloproteins in electron transport processes, cytochromes, ferrodoxins and iron sulphur proteins, metal ion transport and storage: Ionophores and ion pumps, transferrin and ferritin.

UNIT- II **Study of Lanthanides and Actinides** **[15]**

Occurrence, properties of f-block elements, colour, oxidation state, spectral and magnetic properties, lanthanide contraction, use of lanthanide compounds as shift reagents, compounds of lanthanides, photoluminescence properties of lanthanide compounds, modern methods of separation of lanthanides and actinides, oganometallic chemistry of lanthanides and actinides, applications of lanthanide and actinide compounds in Industries.

References:

1. Inorganic Chemistry - Principles, structure and reactivity, J. H. Huheey, Harper and Row Publisher, Inc. New York (1972)
2. Concise inorganic Chemistry, J. D. Lee, Elbs with Chapman and Hall, London
3. Theoretical Inorganic Chemistry, M. C. Day and J. Selbin, Reinhold, EWAP,
4. Elementary coordination Chemistry, Jones.
5. Coordination Chemistry,Martell.
6. Principles of Inorganic Chemistry, Puri& Sharma
7. Coordination chemistry, Pimpalapure-Jain-Sahai-Jainsoni-Pimpalapure
8. Bioinorganic Chemistry, K. Hussain Reddy
9. Advanced Inorganic chemistry,F. A. Cotton, R. G. Wilkinson.
10. Fundamental Concepts of Inorganic Chemistry (Vol I to VII), A.K. Das and M. Das, CBS Publishers.

Section II: Organic Chemistry

UNIT-I **Stereochemistry** **[15]**

Concept of chirality,Symmetry elements; R,Sand E, Z nomenclature; Prochiral relationship, homotopic, enantiotopic and disteriotopic groups and faces;Recemic modifications/mixture formation and their resolution; Conformational analysis: Cyclohexane derivatives, stability and reactivity,Conformational analysis of disubstituted cyclohexanes; Introduction of optical activity in the absence of chiral carbon (spiranes and allenes).

UNIT-II **(A) Reaction Mechanism: Structure and Reactivity** **[8]**

Generation, structure, stability and reactivity of carbocations and carbanions, free radicals, arynes, carbenes, *N*-heterocylcic carbene, nitrenes and Nitrogen,

sulphur and phosphorus ylides.

(B) Elimination Reactions [7]

The E1, E2 and E1cB mechanisms. Orientation in Elimination reactions. Hofmann versus Saytzeff elimination, Pyrolytic syn-elimination, competition between substitution andelimination reactions, Reactivity: effects of substrate structures, attacking base, the leaving group, the nature of medium on elimination reactions.

References:

1. A guide book to mechanism in Organic chemistry (Orient-Longmens) - Peter Sykes.
2. Organic Reaction Mechanism (Benjamin) R. Breslow.
3. Mechanism and Structure in Organic chemistry (Holt Reinh.)E. S. Gould.
4. Organic Chemistry (McGraw-Hill)Hendrikson, Cram and Hammond.
5. Basic principles of Organic Chemistry (Benjamin) J. D.Roberts and M. C. Caserio.
6. Stereochemistry of Carbon compounds. (McGraw-Hill) E.L.Eliel.
7. Organic Stereochemistry (McGraw-Hill) by Hallas.
8. Organic Reaction Mechanism (McGraw-Hill) R. K. Bansal.
9. Organic Chemistry- R. T. Morrison and R. N. Boyd, (Prentice Hall.)
10. Modern Organic Reactions(Benjumin) H. O. House

M. Sc. Chemistry Part – I: Semester – I

CH.102: DSC-II: Major Paper: Physical &Analytical Chemistry

(DSC14CHE12)

Course Outcomes: After the completion of the course, the student will be able to:

CO1 Learn and understand quantum Chemistry, Heisenberg's uncertainty principle, concept of energy operators (Hamiltonian), Schrodinger wave equation, Physical interpretation of the ψ and ψ2. Particle in a one dimensional box.

CO2 Know about chemical and physical methods of kinetics of a reaction, Steady state approximation and its examples, Classification of catalysis, mathematical expression of autocatalytic reactions, Michaelis–Menten enzyme catalysis,

CO3 Demonstrate a comprehensive understanding of quality control techniques, quality management systems, GLP, and GMP in analytical chemistry and pharmaceutical industries.

CO4 Gain proficiency in NMR and MS techniques and deduce structural information of organic compounds.

Section I: Physical Chemistry

UNIT -I Quantum Chemistry **[15]**

Introduction: Wave-particle duality of material and De Broglie's hypothesis, uncertainty principle, Schrodinger equation, wave function, conditions for acceptable wave functions and its interpretation, properties of wave functions, Operators and related theorems, algebra of operators, commutator, linear operators, Normalization and orthogonality, Eigen functions and Eigen values, postulate of quantum mechanics. Solutions of wave equation for a free particle and particle in a box problem, Transition dipole moment integral and selection rules, particle in a box application to electronic spectra of conjugated linear organic molecules. Linear and angular momentum operators, eigen function and eigen values of angular momentum operator, Ladder operator, addition of angular momenta. Spin angular momenta, symmetric and antisymmetric wavefunctions, Pauli Exclusion Principle, spectroscopic term symbols.

UNIT-II Chemical Kinetics **[15]**

Introduction to basic concepts, Experimental methods of following kinetics of a reaction, chemical and physical (measurement of pressure, volume, EMF, conductance, diffusion current and absorbance) methods and examples. Steady state approximation and study of reaction between NO2 and F2, decomposition of ozone, and nitrogen pentoxide. Ionic reaction: Primary and secondary salt effect,

Catalysis:

Classification of catalysis, mathematical expression of autocatalytic reactions,Michaelis–Menten enzyme catalysis, Homogeneous catalysis: acid and base catalyzed reactions, Heterogeneous catalysis: Adsorption of gas on a surface and its kinetics, Catalyzedhydrogen-deuterium exchange reaction.

References:

1. Physical Chemistry – P. W. Atkins, Oxford University press, 8th edition, 2006.
2. Text book of Physical Chemistry – S. Glasstone.
3. Principles of Physical Chemistry – Marron and Pruton.
4. Physical Chemistry – G. M. Barrow, Tata-McGraw Hill, Vth edition, 2003.
5. Introduction to Colloid and Surface Chemistry – D. Shaw, Butterworth Heinemann, 1992.
6. Surface Activity: Principles, Phenomena and Applications (Polymers, Interfaces
7. and Biomaterials) – K. Tsujii, 1st Ed. Academic Press, 1998.
8. Molecular Spectroscopy-Arun Das.
9. Physical Chemistry throughout problems- Dogra and Dogra.

Section II: Analytical Chemistry

UNIT-I Introduction to Quality Control and Quality Assurance **[15]**

a) Control Charts: Introduction, Concepts and significance, Quality control and statistical techniques: Quality control charts, the X-quality control chart, the R-quality control chart and its interpretation, Problems based on X & R chart.

b) Quality in Analytical Chemistry: Quality Management System, total quality management, cost and benefits of quality system, quality audits, types of quality standards for laboratories.

c) Good Laboratory Practices: Principles of GLP, GMP in Drugs and

Pharmaceutical Industries, Accreditation of QC laboratories, ICH Guidelines on Drug substances and Products, Validation of analytical methods

UNIT-II **a) Nuclear Magnetic Resonance (NMR)** **[08]**

Introduction, principles, Magnetic and non-magnetic nuclei, precessional motion, Larmor frequency, absorption of radio frequency. Instrumentation (FT-NMR). Sample preparation, shielding and deshielding effects, chemical shift, internal standards, factors influencing chemical shift, solvents used, peak area and proton ratio, anisotropic effect, spin-spin coupling, coupling constant, applications to simple structural problems

b) Mass spectroscopy (MS) **[07]**

Introduction, Principle, Instrumentation, working of mass spectrometer (double beam). Determination of molecular formula, Formation of different types of ions, Mclaffertyrearrangements, metastable ions or peaks, The nitrogen rule, Mass spectrum of alkanes, alkenes, alkynes, cycloalkanes, cycloalkenes, cycloalkynes, and applications.

Reference Books:

1. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi.
2. Spectroscopic methods in organic chemistry- D.H. Williams and I. Fleming
3. Instrumental methods of chemical analysis, H. Kaur, Pragati Prakashan.
4. E. De. Hoffmann, J. Charette, V. Stroobant, Mass Spectroscopy: Principles and Applications, John Wiley & Sons, Masson, Paris 1996.
5. J. H. Gross, Mass Spectroscopy: A Text book, Springer-Verlag Berlin 2004.
6. C. G. Herbert, R. A. W. Johnstone, Mass Spectrometry Basics, CRC Press, Boca Raton, Florida, 2002.
7. K. Benjamin : Mass Spectrometry
8. G. H. Morrison and H, Freiser: Solvent Extraction in Analytical Chemistry (John Wiley New York, 1958).
9. Willard, Merrit and Settle: Instrumental Methods of analysis.
10. Principles of instrumental analysis- Holler, Skoog and Crouch
11. Instrumental Methods of analysis: Willard, Merrit and Settle.
12. Introduction to Spectroscopy: Pavia, Lampman, Kriz and Vyvyan.
13. Instrumental Methods of analysis: B.K. Sharma

M. Sc. Chemistry Part – I Semester – I

Elective Paper (Students can select any one paper from following)

DSE - I: Elective Paper I: Inorganic Chemistry (Advanced Inorganic Chemistry) (DSE14CHE11)

Course Outcomes: After the completion of the course, the student will be able to:

CO1 Improve the level of understanding of structure, method of preparation, reactions and applications of organometallic compound in various fields.

CO2 Gain a thorough knowledge of preparation, structure, physical and chemical properties of metal carbonyls and their related compounds.

CO3 Grasp the synthesis and applications of the inorganic materials in optical, electrical and electronic devices.

CO4 Study of all chemical properties of solutes in Chemistry and develop interest in various nuclear reactions and applications of radioactivity in various fields.

UNIT-I **Chemistry of Organometallic Compounds** **[15]**

Synthesis, bonding, structure and reactivity of organometallic compounds, classification of organometallic compounds based on hapticity and polarity of M-C bond, nomenclature and general characters, 18 electron rule-applications and exceptions, reactions of organometallic compounds: oxidative addition, reductive elimination, insertion and elimination, organometallics in homogeneous catalysis: hydrogenation, hydroformylation, isomerisation and polymerization.

UNIT-II **Chemistry of Transition metal carbonyls and related compounds** **[15]**

Introduction, preparation, structure, physical and chemical properties of metal carbonyls, anionic and cationic carbonyl complexes, lewis base derivatives of carbonyls, carbonyl hydrides, carbonyl halides, miscellaneous derivatives of metal carbonyls, nitrosyl complexes of transition metals, complexes of molecular nitrogen, cyanide complexes of transition metals.

UNIT-III **Electronic, Electric and Optical behaviour of Inorganic materials** **[15]**

Metals, insulators and semiconductors, electronic structure of solid, band theory, band structure of metals, insulators and semiconductors, intrinsic and extrinsic semiconductors, doping of semiconductors and conduction mechanism, the band

gap, temperature dependence of conductivity, carrier density and carrier mobility in semiconductors, synthesis and purification of semiconducting materials, single crystal growth, zone refining, fractional crystallization, semiconductor devices, rectifier transistors, optical devices, photoconductors, photovoltaic cells, solar batteries.

UNIT-IV **a) Non-aqueous solvents** **[07]**

Classification of solvents, characteristics of solvents, types of reactions in solvents, physical and chemical properties of the non-aqueous solvents such as liquid ammonia, sulphur dioxide, dinitrogen tetroxide, anhydrous sulphuric acid and molten salts.

b) Nuclear and radiochemistry **[08]**

Nuclear stability and nuclear binding energy, radioactivity and radioactive decay, radioactive equilibrium, classification of nuclear reactions, Q value, nuclear reaction cross-sections, nuclear fission, nuclear fusion, applications of radioactivity.

References:

1. Concise inorganic Chemistry, J. D. Lee, Elbs with Chapman and Hall, London
2. Elementary coordination Chemistry, Jones.
3. Coordination Chemistry, Martell.
4. Principles of Inorganic Chemistry, Puri & Sharma
5. Coordination chemistry, Pimpalapure-Jain-Sahai-Jainsoni-Pimpalapure
6. Advanced Inorganic chemistry, F. A. Cotton andR. G. Wilkinson.
7. Fundamental Concepts of Inorganic Chemistry (Vol I to VII), A.K. Das and M. Das, CBS Publishers.
8. Concise Coordination Chemistry, R. Gopalan, V. Ramlingam
9. Essentials of Nuclear Chemistry, W. J. Arnikar, John Wiley
10. An Introduction to Nuclear Physics: R. Babber. And Puri.

M. Sc. Chemistry Part – I Semester – I

DSE - II: Elective Paper II: Organic Chemistry: Basics in Organic Chemistry (DSE14CHE12)

Course Outcomes: After the completion of the course, the student will be able to:

CO1 Study the SN^2, SN^1, mixed SN^1 and SN^2, SN^i mechanisms. Along with this, they will also gain information about neighbouring group participation by pi and sigma bonds, and anchimeric assistance.

CO2 Understand Delocalized chemical bonding, Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel'srule, annulenes, and antiaromaticity.

CO3 Learn about the hydroboration reactions of alkenes and alkynes and identify the mechanism involved and regio-stereo-chemistry of hydroboration.

CO4 Understand the importance of organo-lithium, copper, aluminium, zinc, titanium, mercury and cobalt in organic synthesis.

UNIT-I **a) Aliphatic Nucleophilic substitutions** **[15]**

The SN2, SN1 and SNi reactions with respects to mechanism and stereochemistry. Nucleophilic substitutions at an allylic, aliphatic trigonal, benzylic, and vinylic carbons. Reactivity effect of substrate structure, effect of attacking nucleophiles, leaving groups and reaction medium. SN reactions at bridge head carbon, competition between SN1 and SN2, Ambident nucleophiles, Neighbouring Group Participation.

b) Study of following rearrangement reactions

Schmidt, Curtius, Lossen, Cope, Favorskii, Wagner-Meerwein, Payne, Von Richter rearrangement, Pummerer rearrangement.

UNIT-II **a)Aromatic Electrophilic Substitutions** **[8]**

Introduction, the arenium ion mechanism, orientation and reactivity in Nitration,Sulphonation, Friedel-Crafts and Halogenation in aromatic systems, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in their ring systems. Diazo-coupling, VilsmeierHaak reaction, Nucleophilic aromatic substitution reactions SN1, SN2.

b) Non benzenoid aromatic Compounds [7]

Aromaticity in Non- benzenoids compounds Annulenes and heteroannulenes, fullerence C60, tropone, tropolone, azulene, fulvene, tropylium salts, ferrocene.

UNIT-III **a) Hydroboration** [5]

Introduction, Various hydroborating agents their mechanism and synthetic applications viz 9-borabicyclo-[3.3.1]nonane (9-BBN), Thexylborane, Disiamylborane (Sia_2BH) $BH_3 \cdot SMe_2$. (BMS), Borane as reducing agent.

b) Enamines [3]

Formation,reactivity and synthetic applications of enamines

c) Protection of functional group [7]

Principle of protection of alcohol, amine, carbonyl and carboxyl groups.

UNIT-IV **Study of organometallic compounds** [15]

Organo-lithium, copper, aluminium, zinc, Titanium, Mercury, Cobalt.

Reference Books

1. Modern synthetic reactions-(Benjamin) H. O. House.
2. Reagents in organic synthesis-(John Wiley) Fieser and Fieser
3. Principles of organic synthesis-(Methuen) R. O. C. Norman
4. Hydroboration- S. C. Brown.
5. Advances in Organometallic Chemistry- (A.P.) F. C. A. Stone and R. West.
6. Organic Chemistry (Longman)Vol. I & Vol. II- Finar
7. Oxidation by-(Marcel Dekker) Augustin
8. Advanced Organic chemistry 2nd Ed. R R. Carey and R. J. Sundburg
9. Organic Synthesis-(Prentice Hall) R. E. Ireland.
10. Homogeneous Hydrogenation-(J. K.) B. R. James.
11. Comprehensive Organic Chemistry- (Pargamon) Barton and Ollis.
12. Organic reactions- various volumes- R. Adams.
13. Some modern methods of Organic synthesis-(Cambridge) W. Carruthares.
14. Organic chemistry- Jonathan clayden

M. Sc. Chemistry Part – I Semester – I

DSE - III: Elective Paper III: Physical Chemistry: Basics in Organic Chemistry (DSE14CHE13)

Course Outcomes: After the completion of the course, the student will be able to:

CO1 Gain knowledge about spectroscopy, Electromagnetic spectrum, Study of rotational spectra of diatomic molecules: Rigid rotor model, Infrared spectroscopy, vibrational spectra of diatomic molecules, Born Oppenheimer approximation.

CO2 Adopt information about activity, types of electrodes, acid and alkaline storage batteries and electrokintic phenomenon.

CO3 Grasp the knowledge of sol, micelle, BET equation and applications of photoelectron spectroscopy.

CO4 Learn about polymer, methods of determining molecular weights, Polymer processing techniques, and rubber.

UNIT I **Molecular Spectroscopy** **[15]**

Rotation spectra: Classification of molecules based on moment of inertia, rigid rotor, **Molecular Spectroscopy**

Rotation spectra: Classification of molecules based on moment of most intense line, isotopic effect on the rotational spectra, non-rigid rotator, diatomic molecules, linear triatomic molecules, symmetric top molecules, stark effect.

Infra red spectroscopy: Diatomic molecule, selection rule, anharmonicity, Morse potential, justifying the form of Morse potential, combinations of overtones, and hot bands in polyatomic molecules.

Vibrational rotational Spectra: fine structure in diatomic molecules, break down of the Born Oppenheimer approximation, effect due to nuclear spin, parallel and perpendicular vibrations.

Numerical problems.

UNIT II **Photochemistry** **[15]**

Absorption of light and nature of electronic spectra, electronic transition, Frank-Condon principle, selection rules, photo-dissociation, pre-dissociation, Photo physical phenomena: Electronic structure of molecules, molecular orbital, electronically excited singlet states, designation based on multiplicity rule, life

time of electronically excited state, construction of Jablonski diagram, electronic transitions and intensity of absorption bands, photo-physical pathways of excited molecular system (radiative and nonradiative), prompt fluorescence, delayed fluorescence, and phosphorescence, fluorescence quenching: concentration quenching,

UNIT III **Colloids and Surface Phenomena** **[15]**

Colloidal Systems-Sols, Lyophilic and lyophobic sols, properties of sols, coagulation. Sols of surface active reagents, surface tension and surfactants, electrical phenomena at interfaces including electrokinetic effects, micelles, reverse micelles, solubilization. Thermodynamics of micellisation, critical micelle concentration, factors affecting critical micelle concentration (cmc), experimental methods of cmc determination, Micellar catalysis. Adsorption, adsorption isotherms, methods for determining surface structure and composition, BET equation, surface area determination, Gibbs adsorption equation and its verification. Application of photoelectron spectroscopy, ESCA and Auger spectroscopy to the study of surfaces. Numerical Problems

UNIT IV **a) Polymer** **[15]**

Introduction, Classification and Mechanism of polymerization (Chain and Step), molecular weight & size of polymer molecules, average molecular weight-Number, weight and viscosity average, methods of determining molecular weights (Osmometry, viscometry, light scattering, diffusion and ultracentrifugation), Degree of polymerization and molecular weight, polydispersity and molecular weight distribution in polymers, practical significance of polymer molecular weight, Glass transition temperature, determination of glass transition temperature and affecting factors, plasticizers. Polymer processing techniques, conducting polymers classification and applications, Flory-Huggins Theory. Numerical problems.

b) Rubber

Introduction-concentration and coagulation of Latex-classification, Types of Rubber- modification of natural rubber, terminology, mixing Mechanism and types of mixing and processing.

Reference books

1. Physical Chemistry – R.S. Berry, S.A. Rice, J. Ross, 2nd Ed., Oxford UniversityPress, New York, 2000.
2. Photochemistry– J. G. Calverts and J. N.Pitts,John-Wiley&Sons
3. Fundamentals of Photochemistry- K.K. Rohatgi-Mukharjii, Wiley Eastern
4. IntroductiontoPhotochemistry-Wells
5. Photochemistryof solutions-C. A. Parker, Elsevier
6. ElectrolyticSolutions byR. A.Robinson andR. H.Strokes, 1959
7. ChemicalKinetics-K.J.Laidler,PearsonEducation,2004
8. KineticsandMechanism-A.A.Frost andR.G.Pearson.
9. Colloid and Surface Chemistry by E.D. Shchukin, A.V. Pertsov, E.A. Amelina, A.S. Zelenev
10. AdvancedPhysicalChemistry-GurdeepRaj,GoelPublishingHouse
11. BasicchemicalKinetics-G.L. Agarwal,Tata-McGrawHill
12. PhysicalChemistry–G.M.Barrow,Tata-McGrawHill, Vthedition,2003.
13. Polymer Science by R. Gowariker

M. Sc. Chemistry Part – I Semester – I

DSE - IV: Elective Paper IV: Analytical Chemistry (DSE14CHE14)

Course Outcomes: After the completion of the course, the student will be able to:

CO1 Learn about the introduction of electronic and Raman spectroscopy. They are also able to explain the difference between Stokes and anti-Stokes lines in a Raman spectrum. Justify the difference in intensity between Stokes and anti-Stokes lines.

CO2 Explain the principles and operation of a range of advanced techniques such as X-ay, spectroscopic, microscopic, and used in the characterization of various materials and compounds.

CO3 Learn about thermal, and electroanalytical, currently used in the characterization of various materials and compounds.

CO4 Grasp about the instrumentation and applications of AAS and ICP in trace elements analysis. They will also learn about the plasma torch and precise optical sensors

UNIT -I **Spectroscopic Techniques** **[15]**

a) **Introduction to Spectroscopy:** Introduction, region of electromagnetic radiations, definitions and units of wavelength, frequency, energy, amplitude, wave number and their relations, radiation interactions with matter, rotational, vibrational, electronic energy levels, types of spectroscopy methods.

b) **Electronic spectroscopy:** Diatomic molecules, selection rules, breakdown of selection rules, Franck-Condon factors, Dissociation energies, Photoelectron spectroscopy of diatomic (N_2) and simple polyatomic molecules (H_2O, Formaldehyde), Adiabatic and vertical ionization energies, Koopman's theorem. Numerical problems.

c) **Raman spectroscopy:** Rayleigh and Raman scattering, quantum and classical theories of Raman Effect, pure rotational Raman spectra of linear and symmetric top molecules, Raman activity of vibrations, rule of mutual exclusion, vibrational Raman spectra, and rotational fine structure.

UNIT-II **Surface Characterization by Spectroscopy** **[15]**

Introduction, Definition of Solid surface, Some common Spectroscopic

methods for analysis of surfaces.

a) **Electron Scattering Chemical Analysis (ESCA) or X-ray Photoelectron Spectroscopy:** Principle, instrumentation, qualitative and quantitative applications.

b) **Auger spectroscopy:** Principle, instrumentation, qualitative and quantitative applications.

c) **Secondary ion-mass spectrometry:** Principle, instrumentation, qualitative and quantitative applications.

d) **Ion Scattering and Rutherford backscattering Spectroscopy:** Principle, instrumentation, qualitative and quantitative applications.

UNIT-III Electroanalytical Techniques [15]

a) **Polarography**: Introduction, Instrumentation, Ilkovic equation and its verification. Polarographic measurements, Dropping mercury electrode, Determination of half wave potential, qualitative and quantitative applications

b) **Amperometry:** Basic principles, instrumentation, Amperometric titration curves, Amperometric indicators, procedure for Amperometric titrations, Evaluation of amperometry in research and analytical applications.

c) **Voltametry:** Voltammetric methods of analysis, basic principles, instrumentation, voltammetric measurements, voltametric techniques, current in voltammetry, shape of voltammograms, quantitative and qualitative aspects of voltammetry, quantitative applications, characterization applications, Evaluation of CV in research and analytical applications

Unit - IV Atomic absorption and Inductively coupled plasma (ICP) Spectroscopy [15]

a) **Atomic Absorption Spectroscopy (AAS):** Introduction, Principal, difference between AAS and FES, Advantages of AAS over FES, advantages and disadvantages of AAS, Instrumentation, Single and double beam AAS, detection limit and sensitivity, Interferences, applications. Graphite furnace atomic absorption spectroscopy, general

description, advantages and disadvantages. Flame photometry, Cold Vapor Mercury, Hydride Generation, Spark emission, challenges and limitations.

b) **Inductively Coupled Plasma Spectroscopy:** Introduction, Nebulisation Torch, Plasma, Instrumentation, Interferences, and Applications.

c) **Problems:** Simple problems based on AAS and ICP

Reference Books:

1. Spectroscopic methods in organic chemistry- D.H. Williams and I. Fleming.
2. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi.
3. Instrumental methods of chemical analysis, H. Kaur, Pragati Prakashan.
4. E. De. Hoffmann, J. Charette, V. Stroobant, Mass Spectroscopy: Principles and Applications, John Wiley & Sons, Masson, Paris 1996.
5. J. H. Gross, Mass Spectroscopy: A Text book, Springer-Verlag Berlin 2004.
6. C. G. Herbert, R. A. W. Johnstone, Mass Spectrometry Basics, CRC Press, Boca Raton, Florida, 2002.
7. K. Benjamin : Mass Spectrometry
8. G. H. Morrison and H, Freiser: Solvent Extraction in Analytical Chemistry (John Wiley New York, 1958).
9. Willard, Merrit and Settle: Instrumental Methods of analysis.
10. Principles of instrumental analysis- Holler, Skoog and Crouch
11. Instrumental Methods of analysis: Willard, Merrit and Settle.
12. Introduction to Spectroscopy: Pavia, Lampman, Kriz and Vyvyan.
13. Instrumental Methods of analysis: B.K. Sharma

M. Sc. Chemistry Part – I Semester – I

RMD-I: Research Methodology (RMD14CHE11)

Course Outcomes: After the completion of the course, the student will be able to:

CO1: Acquire knowledge about fundamental concepts of research methodology and develop research aptitude.

CO2: Inculcate mechanics of report writing and interpretation

CO3: Understand the role and applications of computers and various software in the area of research and development.

CO4: Analyze the data with the help of various advanced instrumental techniques.

UNIT-I **Fundamentals of Research methodology:** **[15]**

- Meaning, Objectives, Motivation andTypes of Research
- Research Approaches.
- Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is done?
- Criteria of Good Research, research process and steps involved
- Hypothesis: Meaning, function and types of hypothesis; Null/Alternative hypothesis
- Literature survey, sources of information, review.
- Ethical issues and intellectual property rights.
- Publication process, selection of journals, citation index, impact factor, h-index, i10 index, Journal Cite Score, Google scholar index, Research gate, Academia, etc.

UNIT-II **Interpretation and Report Writing** **[15]**

- Meaning of Interpretation, Why Interpretation?Technique of Interpretation, Precaution in Interpretation.
- Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports
- Mechanics of Writing a Research Report: Writing preliminaries, main body of research, references and bibliography.

- Precautions for Writing Research Reports.
- Meaning and importance of workshop, seminar, conference, symposium, etc. in research.
- Plagiarism- Concept and significance of plagiarism.
- Writing tools: Grammerly, Answerthepublic, Quillbot, Notion, Buzzsumo, Copyscape, Chatgpt, ginger.
- Referencing and citation tools: Endnote, Mendeley, Jabref, Zotero.

UNIT-III **Computer Applications** **[15]**

- DatabaseSearch Engines:Scirus, reaxys, Synthia, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus, inflibinet, Cambridge structural database, Web of Science, Indian Citation Index.
- Publishers in Chemical Sciences: American Chemical Society, Royal Society of Chemistry, Taylor and Francis, Elsevier, Springer, Bentham, Wiley, Themie.
- Chemometrics: Computer-based laboratory, statistics, and data interpretation,Computer-based information systems for e.g docking.
- Software for Chemistry: Chemdraw,Chemdoodle, Marvinsketch, Origin, MestreNova, XRD Software

UNIT-IV **Data Interpretation by following techniques** **[15]**

General introduction of interpretation of spectral data by following techniques:

- UV-Visible, IR, NMR, Mass
- SEM, TEM-SAED Pattern, EDX, AFM
- XRD, XPS
- TGA, DSC, DTA,
- BET, Particle Size Analyzer
- VSM (Vibrating Sample magnetometer)

Reference Books:

1. Kumar R., Research Methodology - A Step-By-Step Guide for Beginners, Pearson Education, Delhi (2006).
2. Montgomery, D. C., Design & Analysis of Experiments, 5th Ed., Wiley India (2007).
3. Kothari, C. R., Research Methodology-Methods and Techniques, 2nd Ed., New Age International, New Delhi.
4. Ram Ahuja, "Research Methods", (2001), Rawat Publications, New Delhi.
5. Cooper D., Schindler P., Business research methods", (2003) Tata Mc-GrawHill,New Delhi

M. Sc. Part I Semester-I

Practical Course (104 & 105) DSC-PR-I: DSC03CHE19 (Credits 4+2)

INORGANIC CHEMISTRY PRACTICALS

1. **Ore analysis** – '2' ores (iron and pyrolusite ore)
2. **Alloy analysis** – '2' (Solder metal and Cupro-Nickel alloy: Two components)
3. **Inorganic Preparations and purity** – '4'
   - i) Hexathioureaplumbus (II) nitrate
   - ii) Nickel ammonium sulphate
   - iii) Tris(acetylacetonato) manganese (III) complex
   - iv) Hexammine cobalt (III) chloride
   - v) Prussian blue

Note: Any suitable experiment may be added

Reference books:

1. A text book of Quantitative Inorganic Analysis – A. I. Vogel
2. Advanced Practical Inorganic Chemistry- Gurudeep Raj
3. Practical Inorganic Chemistry- ShikhaGulati, J L Sharma, ShagunManocha
4. Experimental Inorganic Chemistry - W. G. Palmer
5. The analysis of minerals and ores of the rarer elements – W. R. Schoeller and A.R. Powell, Charles, Griffin and Company Limited

ORGANIC CHEMISTRY PRACTICALS

A) Preparations: (One stage preparations involving various types of reactions and confirmation of product by TLC: Minimum 6 preparations) (Major 4 Credits)

1. Coumarin Synthesis- 7-OH-4-methyl coumarine from Resorcinol and EAA.
2. Knoevenagel condensation reaction-Reaction of aldehyde and malononitrile.
3. Preparation of Hydrantoin.
4. Synthesis of triazoles- Reaction of aldehyde and thiosemicarbazide.
5. Preparation of benzimidazole from OPD
6. Preparation of Orange II
7. Fischer Indole Synthesis-Reaction of phenyl hydrazine and cyclohexanone.

(Any suitable preparation may be added)

B) Estimations: (Minimum 3estimations) (Minor 2 Credits)

1. Estimation of Unsaturation.
2. Estimation of formalin.
3. Colorimetric Estimation of Dyes.
4. Estimation of Amino acids.
5. Estimation of Glycine.
6. Any suitable Expt. may be added.

RECOMMENDED BOOKS:

1. A text book of practical organic chemistry- A. I. Vogel.
2. Practical organic chemistry- Mann and Saunders.
3. A handbook of quantitative and qualitative analysis- H. T. Clarke.
4. Organic Synthesis Collective Volumes by Blat.
5. Practical Med. Chem.-Dr. K. N. Jayveera, Dr. S. Subramanyam, Dr. K. Yogananda Reddy.

PHYSICAL CHEMISTRY PRACTICALS

Physical Chemistry Students are expected to perform experiments of three and half hours duration. Experiments are to be set up in the following techniques.

1. Potentiometry

1. Determination of solubility and solubility product of silver halides.
2. Determination of binary mixture of weak and strong acid etc.

2. Conductometry

1. Determination of ternary mixture of acids and relative strength of weak acids.
2. Determination of solubility of lead sulphate.
3. Determination of CMC and ΔG of sodium dodecyl sulphate.

3. Refractometry

1. Determination of molecular radius of molecule of organic compound.

4. pH- metry

1. Determination of dissociation constant of dibasic acid.

5. Chemical Kinetics

1. Kinetics of reaction between bromate and iodide.

6. Viscosity

1. Determination of molecular weight of polymers

7. Adsorption

1. Study of adsorption of acetic acid on charcoal. (New experiments may also be added)

Reference books

1. Findlay's Practical Chemistry – Revised by J.A. Kitchner (Vedition)
2. Text Book of Quantitative inorganic analysis: A.I. Vogel.
3. Experimental Physical Chemistry :R.C. Das and B. Behera
4. Practical Physical Chemistry : B. Viswanathan and P.S. Raghavan
5. Experimental Physical Chemistry: V.D. Athawale and Parul Mathur.
6. Systematic Experimental Physical Chemistry: S.W. Rajbhoj and T.K. Chondhekar

M. Sc. Chemistry Part – I: Semester – II

CH. 201: DSC-III: Major Paper: Inorganic & Organic Chemistry

(DSC14CHE21)

Course Outcomes: After the completion of the course, the student will be able to:

CO1: Study the synthesis, properties and structure of halides and oxides of the non - transition elements.

CO2: Gain an understanding of spatial arrangement and the nature of bonding in the case of main group compounds and important aspects of the stability of metal complexes.

CO3: Understand the organic reactions induced by photons, especially by various functional groups, and their mechanism

CO4: Know about the types of organic transformations based on the name of the reaction and mechanisms as well as applications of these name reactions in organic synthesis.

Section I: Inorganic Chemistry

UNIT-I **Chemistry of non – Transition elements** **[15]**

General discussion on the properties of the non - transition elements, special features of individual elements, synthesis, properties and structure of halides and oxides of the non - transition elements, polymorphism in carbon, phosphorous and sulphur, synthesis, properties and structure of boranes, carboranes, silicates, carbides, phosphazenes, sulphur - nitrogen compounds, peroxo compounds of boron, carbon, sulphur, structure and bonding in oxyacids of nitrogen, phosphorous, sulphur and halogens, interhalogens, pseudohalides.

UNIT - II **A) Stereochemistry and bonding in main group compounds** **[08]**

VSEPR theory and drawbacks, bond length, bond angles, bond energies and resonance, $P\pi$ - $P\pi$ and $P\pi$ - $d\pi$ bonds, Bent rule, walsh diagram, back bonding, some simple reactions of covalently bonded molecules(atomic inversion, Berry pseudorotation, nucleophilic displacement and free radical reaction).

B) Metal - ligand equilibria in solution **[07]**

Stability constant, step wise and overall formation constant 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, ternary complexes and factors affecting their stabilities, stability of metal complexes of crown ether, determination of stability constant for binary complexes using pH-metric (Bjerrumsmethod) and spectrophotometric (Job's and mole ratio) techniques.

References:

1. Inorganic Chemistry - Principles, structure and reactivity, J. H. Huheey, Harper and Row Publisher, Inc. New York (1972)
2. Concise inorganic Chemistry, J. D. Lee, Elbs with Chapman and Hall, London
3. Theoretical Inorganic Chemistry, M. C. Day and J. Selbin, Reinhold, EWAP
4. Elementary coordination Chemistry, Jones.
5. Coordination Chemistry, Martell.
6. Principles of Inorganic Chemistry, Puri & Sharma
7. Coordination chemistry, Pimpalapure-Jain-Sahai-Jainsoni-Pimpalapure
8. Advanced Inorganic chemistry, F. A. Cotton and R. G. Wilkinson.
9. Fundamental Concepts of Inorganic Chemistry (Vol I to VII), A.K. Das and M. Das, CBS Publishers.
10. Concise Coordination Chemistry, R. Gopalan, V. Ramlingam

Section II Organic Chemistry

UNIT–I **Photochemistry** **[15]**

Effect of light intensity on the rate of photochemical reactions, Types of photochemical reactions, phtodissociation gas phase photolysis, photochemistry of alkynes, intramolecular reactions of the olefinic bonds, geometrical isomerism, cyclisation reactions, rearragements of 1,4 and 1,5-dienes, photochemistry of carbonyl compounds, intramolecular reactions of carbonyl compounds saturated cyclic and acyclic α, β-unsaturated compounds, cyclohexadienones, intermolecular cycloaddition reactions, dimerisation and oxitane formation, photochemistry of aromatic compounds, photo fries reactions of anilides, photo fries rearrangements, Singlet molecular oxygen reactions, photochemistry of vision.

UNIT-II Study of following reactions **[15]**

Mechanism of condensation reaction involving enolates, Arndt-Eistert, Stobbe, Simon-Smith, Ulmann, Mc-Murry, Prins,Nef reaction, Passerini, Baylis-Hilman, Mitsunobu, Darzen, Duff, Click reaction.

RECOMMENDED BOOKS:

1. Modern synthetic reactions-(Benjamin) H. O. House.
2. Reagents in organic synthesis-(John Wiley) Fieser and Fieser
3. Principles of organic synthesis-(Methuen) R. O. C. Norman
4. Hydroboration- S. C. Brown.
5. Advances in Organometallic Chemistry- (A.P.)F. C. A. Stone and R. West.
6. Organic Chemistry (Longman)Vol. I & Vol. II- Finar
7. Oxidation by-(Marcel Dekker) Augustin
8. Advanced Organic chemistry 2nd Ed. R R. Carey and R. J. Sundburg
9. Organic Synthesis-(Prentice Hall)R. E. Ireland.
10. Homogeneous Hydrogenation-(J. K.) B. R. James.
11. Comprehensive Organic Chemistry- (Pargamon) Barton and Ollis.
12. Organic reactions- various volumes- R. Adams.
13. Some modern methods of Organic synthesis-(Cambridge) W. Carruthares.
14. Organic chemistry- Jonathan clayden

M. Sc. Chemistry Part – I: Semester – II

CH. 202: DSC-IV: Major Paper: Physical & Analytical Chemistry

(DSC14CHE22)

Course Outcomes: After the completion of the course, the student will be able to:

CO1 Learn and understand the Entropy, Maxwell relations, Duhem-Margules and Gibbs-Duhem equation, Henry's law.

CO2 Know about activity, types of electrodes, acid and alkaline storage batteries and electrokinetic phenomenon.

CO3 Gain a comprehensive understanding of TGA, DTA, DSC, and their significance in analytical chemistry. They will learn the principles, instrumentation, and working of these techniques, exploring the effects of heat on materials, including chemical decomposition and phase transformation. Additionally, students will analyze TGA curves, interpret compound qualities, and apply thermal analysis methods in research and analytical implications. They will also practice problem-solving in TGA, DTA, and DSC, enhancing their analytical skills in thermal analysis.

CO4 Understand Ultraviolet Spectroscopy and Infrared Spectroscopy. They will gain expertise in identifying characteristic vibrational frequencies of functional groups and explore the effects of hydrogen bonding and solvent on vibrational frequencies.

Section I: Physical Chemistry

UNIT -I **Thermodynamics** **[15L]**

Introduction, revision of basic concepts: Entropy and third law of thermodynamics. Methods of determining the practical absolute entropies. Entropies of phase transition. Maxwell relations and its applications, thermodynamic equation of state. Ideal and non-ideal solutions, Thermodynamics of nonelectrolyte solutions. Raoult's law. Duhem-Margules equation and its applications to vapor pressure curves (Binary liquid mixture). Gibbs-Duhem equation and its applications to study of partial molar quantities. chemical potential, variation of chemical potential with temperature & pressure. Henry's law. Excess and mixing

thermodynamic properties. Equilibrium constants and general conditions of equilibrium in terms of thermodynamic potentials. Numerical Problems.

UNIT II Electrochemistry [15L]

Activity and Activity coefficients: forms of activity coefficients and their interrelationship, Types of electrodes, Determination of activity coefficients of an electrolyte using concentration cells, instability constant of silver ammonia complex. Acid and alkaline storage batteries, Abnormal ionic conductance of hydroxyl and hydrogen ions. Electrokinetic phenomena: Electrical double lever, theories of double layer-Helmholtz-Perrin theory, Gouy and Chapman theory, Stern theory. electro-capillary phenomena, electro-capillary curve. Electro-osmosis, electrophoreses. Streaming and Sedimentation potentials. Zeta potentials and its determination by electrophoresis, influence of ions on Zeta potential.

RECOMMENDED BOOKS

1. Principles of Physical Chemistry – Marron and Pruton.
2. Physical Chemistry – G. M. Barrow, Tata-McGraw Hill, Vth edition, 2003.
3. Thermodynamics for Chemists – S. Glasstone, D. Van Nostrand , 1965.
4. Thermodynamics: A Core Course- R. C. Srivastava, S. K. Saha and A. K. Jain,
5. Prentice-Hall of India, IInd edition, 2004.
6. Introduction to Electrochemistry by Glasstone
7. Advanced Physical Chemistry- Gurdeep Raj, Goel Publishing House
8. Modern Electrochemistry Vol. I & II by J. O. M. Bockris and A.K.N. Reddy.

Section II: Analytical Chemistry

UNIT-I: Thermal Analysis methods [15]

Introduction to thermal analysis, types of thermal analysis, significance of thermal analysis in Analytical Chemistry, effect of heat on materials, chemical decomposition, phase transformation etc. and general thermal analysis applications, advantages and disadvantages.

a) Thermogravimetry analysis (TGA): principle, instrumentation,

working, types of TGA, factors influencing TGA, curve to show nature of decomposition reactions, the product and qualities of compounds expelled, TGA in controlled atmosphere, TGA curves, analysis, research and analytical implications of TGA.

b) **Differential thermal analysis (DTA)**: Instrumentation, methodology, application and research implications. Thermometric titrations method and applications

c) **Differential scanning calorimetry (DSC):** Instrumentation, methodology, application and research implications.

d) **Thermometric titrations:** Principle, instrumentation, working and applications

e) Problems: Simple problems based on TGA, DTA and DSC.

UNIT-II:

a) **Ultraviolet Spectroscopy:** Introduction,Woodward- Fisher rules for conjugated dienes and carbonyl compounds; Calculation of λ max. Ultraviolet spectra of aromatic and heterocyclic compounds, Steric effect in biphenyls.

b) **IR Spectroscopy:** Introduction,Characteristic vibrational frequencies of alkanes; alkenes; alkynes; aromatic compounds; alcohols; ethers; phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds [ketones; aldehydes; esters; amides; acids; anhydrides; lactones; lactams and conjugated carbonyl compounds] Effect of hydrogen bonding and solvent effect on vibrational frequencies; overtones; combination bands and Fermi resonance. FT-IR of gaseous; solids and polymeric materials.

Reference Books:

1. Principles of instrumental analysis- Holler, Skoog and Crouch
2. Instrumental methods of Chemical analysis-H. Kaur
3. Instrumental methods of Chemical analysis- Chatwal and Anand.
4. Instrumental Methods of analysis: Willard, Merrit and Settle.
5. Introduction to Spectroscopy: Pavia, Lampman, Kriz and Vyvyan.
6. Instrumental Methods of analysis: B.K. Sharma.

7. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi.
8. Fundamentals of Molecular Spectroscopy by V. M. Parikh

M. Sc. Chemistry Part – I Semester – II

Elective Paper (Students can select any one paper from following)

DSE - V: Elective Paper I: Inorganic Chemistry (Applied Inorganic Chemistry) (DSE14CHE21)

Course Outcomes: After the completion of the course, the student will be able to:

CO1 Get a basic understanding of the medicinal use of metal complexes as antibacterial, antiviral, antibiotics, and related compounds.

CO2 Understand synthetic oxygen carriers, role of globin chain, oxygen storage and its fascinating aspects.

CO3 Impart essential knowledge regarding general properties of polymer, types of phosphorus, silicon and coordination polymer is explained.

CO4 Study the important aspects of the metal complexes in inorganic qualitative analysis, the separation of metals, medicinal chemistry, industrial processes, and agriculture is explained.

UNIT-I **Metal Complexes in Medicine** **[15]**

Medicinal use of metal complexes as antibacterial, antiviral, antibiotics & related compounds. Metal deficiency and disease, iron deficiency, zinc deficiency and copper deficiency, Metals used for diagnosis and chemotherapy with particular reference to anti cancer drugs, Chelate therapy, chemotherapy with compounds of some non essential elements; use of cis-platin as antitumor drug, Gold containing drugs used in the therapy of Rheumatic-Arthritis and cancer, Lithium in psycho pharmacological drugs, Antimicrobial agents.

UNIT-II **Oxygen Transport and Storage** **[15]**

Hemocyanins& hemerythrin, Synthetic oxygen carriers -Collmans compound, Vaskas complex, Co (II) schiff base complexes, perflurochemicals (PFCs), Perutz mechanism for structural changes in porphyrin ring system, Oxygenation and deoxygenation, Oxygen adsorption isotherm and cooperativity, role of globin chain in gaemoglobin, Siderophores, Vanadium compounds as insulin mimetic agents in the treatment of diabetics.

UNIT-III Inorganic Polymers [15]

General Properties, Phosphorous based polymers: chain polymers, and network polymers, Silicon based polymers: Organosilicones or organopolysiloxanes, types of silicones, properties of silicones, Coordination polymers: natural coordination polymers, classification of natural coordination polymers, Synthetic coordination polymers: Volan and quilon polymers, polymers having pthalocyanin and related structure, polymers with bis-chelating agent, polymers of polymeric ligands.

UNIT-IV Applications of Coordination Compounds [15]

Introduction, Metal Complexes in Inorganic Qualitative Analysis, The 'brown ring' test, Complexometric Titrations, Complexes in Colourimetry, Coordination Compounds in Gravimetry, Stabilization of Oxidation States, Complexes in Separation of Metals, Metal Complexes in Medicinal Chemistry: Complexation in Food Poisoning, Metal Complexes in Therapy, Metal Complexes in Industrial Processes: Heavy Metals-protein Complexes in the Rasching Process, The Ziegler-Natta Catalyst, Metal complexes in alkene conversions, Complexes and Electroplating, Complexes in Metallurgy, Copper Metal dissolves in Aqueous Potassium Cyanide, Complexes in water softening, Metal complexes in Agriculture.

Reference:

1. Concise inorganic Chemistry, J. D. Lee, Elbs with Chapman and Hall, London
2. Elementary coordination Chemistry, Jones.
3. Coordination Chemistry, Martell.
4. Principles of Inorganic Chemistry, Puri & Sharma
5. Coordination chemistry, Pimpalapure-Jain-Sahai-Jainsoni-Pimpalapure
6. Advanced Inorganic chemistry, F. A. Cotton, R. G. Wilkinson.
7. Fundamental Concepts of Inorganic Chemistry (Vol I to VII), A.K. Das and M. Das, CBS Publishers.
8. Concise Coordination Chemistry, R. Gopalan, V. Ramlingam
9. Essentials of Nuclear Chemistry, W. J. Arnikar, John Wiley
10. An Introduction to Nuclear Physics: R. Babber. And Puri.

M. Sc. Chemistry Part – I Semester – II

DSE - VI: Elective Paper II: Organic Chemistry: Fundamental Organic Chemistry (DSE14CHE22)

Course Outcomes: After the completion of the course, the student will be able to:

CO1 Understand the applications of different oxidizing reagents and oxidation reactions and their mechanism.

CO2 Understand the applications of different reducing reagents in organic synthesis and their mechanism.

CO3 Know about the different disconnection approaches with chemoselectivity and reversal of polarity, Types of alkylation and alkylating agents.

CO4 Know use of advanced techniques such as supported reagents, magnetic nanoparticles, electro-organic synthesis, ionic liquids, and enzyme catalysed reactions, MCRs, MW and US techniques in organic synthesis.

UNIT-I **Oxidation** **[15L]**

Applications of oxidizing agents like chromium trioxide, manganese dioxide, Chloranil, Swern oxidation, PCC(Corey's reagent), Baeyer-Villiger oxidation. Dakin oxidation, CAN (Ceric Ammonium Nitrate), The babler Oxidation, Corey Kim Oxidation, Wacker Oxidation, HIO_4, Etard oxidation, Dess Martin oxidation.

UNIT-II **Reduction** **[15L]**

Study of following reductions and reducing agents- Catalytic hydrogenation using homogeneous and heterogeneous catalysts. Wolff-Kishner, Birch, $NaBH_4$, Sodium cyano borohydride, Sodium in alcohol, Fe in HCl, Adam's catalyst, Lindlar catalyst,Corey-Bakshi-Shibata reduction (CBS reagent), Zinc borohydride, Luche reduction($CeCl_3$,MeOH), K/L Selectride (LiBH(SEC-Bu_3)).

UNIT-III **[15]**

a) Methodologies in organic synthesis **[10]**

Ideas of synthones and retrones, Disconnection approach, Functional group

properties of organic semiconductors, applications and devices involving optical properties, luminescence photoluminescence, effect of impurity levels on photoluminescence, light emitting diodes, luminous efficiency, photo-conduction and photoelectric effects, laser, principle of laser action, solid state laser and their applications.

UNIT-IV **Preparation of materials** **[15]**

Purification and crystal growth, kinetics of nucleation, radius of nucleus, critical radius, principle of nucleation, crystal growth during casting, zone refining, growth from solution, growth from melt and preparation of organic semiconductors for device applications.

Crystal Defect and Non Stiochiometry

Classification of defects subatomic, atomic and lattice defect in solids. Thermodynamics of vacancy in metals, Thermodynamics of Schottky defects in ionic solids, Thermodynamics of Frenkel defects in silver halides. Calcualtion of number of defects and average energy required for defect.

REFERENCE BOOKS:

1. A guide to laser in chemistry by Gerald R., Van Hecke, Keny K. Karokitis
2. Principals of solid state, H. V. Keer, Wiley Eastern,
3. Solid state chemistry, N. B. Hannay
4. Solid state chemistry , D. K. Chakrabarty , New Age International
5. An Introduction to Crystallography : F. G. Philips
6. Crystal Structure Analysis: M. J. Buerger 50
7. The Structure and properties of materials: Vol. III Electronic properties by John Walss
8. Electronic processes in materials : L. U. Azroff and J. J. Brophy
9. Chemistry of imperfect crystal : F. A. Krogen
10. Elements of X-ray Diffraction by B. D. Cullity, Addison- Weily.
11. Solid state Chemistry by A.R.West (Plenum)
12. Electronics made simple by Jacobwitz.
13. Principles of Physical Metallurgy, by Abhijeet Mallick,
14. Solid State Chemistry, An Introduction, by Lesley E. Smart, & Elaine A. Moore, Third Edition, Taylor & Francis, Indian Edition 2012.

transformations and inter conversions of simple functionalities. One group C-X and two group C-X disconnections, Chemoselectivity, reversal of polarity.

b) Alkylation and Acylation **[05]**

Introduction, Types of alkylation and alkylating agents: C-Alkylation and Acylation of active methylene compounds and their applications.

Unit -IV **Application of the following in synthesis** **[15]**

Supramolecular chemistry (use of crown ethers, cyclodextrins), Merrifield resin for synthesis of polypeptide, use of ferrites and metal nanoparticles in organic synthesis, Electro-organic synthesis, Enzyme catalyzed reaction in synthesis, Ionic liquids, Multi-component reactions, Microwave and Ultrasound techniques and their applications.

RECOMMENDED BOOKS:

1. Modern synthetic reactions-(Benjamin) H. O. House.
2. Reagents in organic synthesis-(John Wiley) Fieser and Fieser
3. Principles of organic synthesis-(Methuen) R. O. C. Norman
4. Hydroboration- S. C. Brown.
5. Advances in Organometallic Chemistry- (A.P.)F. C. A. Stone and R. West.
6. Organic Chemistry (Longman)Vol. I & Vol. II- Finar
7. Oxidation by-(Marcel Dekker) Augustin
8. Advanced Organic chemistry 2nd Ed. R R. Carey and R. J. Sundburg
9. Organic Synthesis-(Prentice Hall)R. E. Ireland.
10. Homogeneous Hydrogenation-(J. K.) B. R. James.
11. Comprehensive Organic Chemistry- (Pargamon) Barton and Ollis.
12. Organic reactions- various volumes- R. Adams.
13. Some modern methods of Organic synthesis-(Cambridge) W. Carruthares.
14. Organic chemistry- Jonathan clayden

M. Sc. Chemistry Part – I Semester – II

DSE - VII: Elective Paper III: Physical Chemistry (DSE14CHE23)

Course Outcomes: After the completion of the course, the student will be able to:

CO1 Know about spectroscopy, Electromagnetic spectrum, Study of rotational spectra of diatomic molecules: Rigid rotor model, Infrared spectroscopy, vibrational spectra of diatomic molecules, Born Oppenheimer approximation will be gained by the students..

CO2 Know about activity, types of electrodes, acid and alkaline storage batteries and electrokinetic phenomenon.

CO3 Gain about Metals, insulators and semiconductors, properties of semi conductor, and applications of the semiconductor.

CO4 Grasp knowledge about material preparation, lattice and atomic defects.

UNIT-I **The solid state** **[15]**

Introduction, laws of crystallography, lattice types, X-ray diffraction, Bragg's equation, Miller indices, Bragg Method, Debye-Sherrer method of X-ray structure analysis of crystals, indexing of reflections, identification of unit cells from systematic absence in diffraction pattern, structure of simple lattice and X-Ray intensities, structure factor and its relation to intensity and electron density, phase problem, procedure for an X-ray structure determination.

UNIT-II **Solid State Reactions** **[15]**

General principle, types of reactions: Additive, structure sensitive, Decomposition and phase transition reactions, tarnish reactions, kinetics of solid state reactions, factors affecting the reactivity of solid state reactions.

UNIT-III **Electronic Properties and Band Theory** **[15]**

Metals, insulators and semi conductors, free electron theory and its applications, electronic structure of solids, band theory, band structure of metals, insulator, and semiconductors, doping in semiconductors, p- n junction, superconductors, Molecular materials, Organic materials, some examples of organic semiconductors, charge carrier injection and transport, Optical

M. Sc. Chemistry Part – I Semester – II

DSE - VIII: Elective Paper III: Analytical Chemistry (DSE14CHE24)

Course Outcomes: After the completion of the course, the student will be able to:

CO1 Gain a comprehensive understanding of chromatographic techniques, including partition chromatography, thin layer chromatography, and column chromatography. They will learn about the general principles, classification, and chromatographic behavior of solutes. They will explore applications and advances in TLC, including modern techniques.

CO2 Develop expertise in advanced gas chromatographic techniques, understanding plate theory, instrumentation, and working of a Gas Chromatograph. They will be familiar with sampling, sample pretreatment, sample injection types, columns, detectors, programmed temperature G.C., and pyrolysis gas and vapor phase chromatography. Moreover, students will gain insights into gas chromatography-mass spectrometry and its applications, as well as the significance of TGA-MS/TGA-GC-MS.

CO3 Achieve proficiency in advanced liquid chromatographic techniques, focusing on high-performance liquid chromatography (HPLC) and ultra-performance liquid chromatography (UPLC). They will learn about the principles, instrumentation, mobile phase, stationary support in HPLC, detectors, and applications. Moreover, they will explore supercritical fluid chromatography (SCFC) and liquid chromatography-mass spectrometry interface, understanding their instrumentation and applications.

CO4 Gain in-depth knowledge of ion chromatography and size exclusion chromatography. They will explore analytical applications and environmental speciation by ion chromatography. Additionally, students will understand the principles and applications of size exclusion chromatography.

UNIT-I: **Study of following chromatographic techniques** **[15]**

a) **Partition Chromatography**: General principle, classification of chromatographic methods, Nature of partition forces, Chromatographic behaviour of solutes, Column efficiency and resolution.

b) **Thin layer chromatography:** Principle, coating materials, solvent-

Chromatography, commercial scope, analytical applications, environmental speciation by Ion Chromatography. Practical applications and examples in analytical chemistry and research.

b) Size Exclusion Chromatography:

Reference Books:

1. Principles of instrumental analysis- Holler, Skoog and Crouch
2. Instrumental methods of Chemical analysis-H. Kaur
3. Instrumental methods of Chemical analysis- Chatwal and Anand.
4. Instrumental Methods of analysis: Willard, Merrit and Settle.
5. Introduction to Spectroscopy: Pavia, Lampman, Kriz and Vyvyan.
6. Instrumental Methods of analysis: B.K. Sharma.
7. Applications of spectroscopic techniques in Organic chemistry- P. S. Kalsi.
8. Fundamentals of Molecular Spectroscopy by V. M. Parikh

M. Sc. Part I Semester-II

Practical Course (204 & 205) DSC-PR-III: DSC03CHE29 (Credits 4+2)

INORGANIC CHEMISTRY PRACTICALS

Ore analysis – '2' ores (Dolomite and pyrolusite ore)

Alloy analysis – '2' (Brass and Steel alloy: Two components)

Inorganic Preparations and purity –'4'

a) Potassium dioxalatodihydroxomangnate (IV)

b) Ammonium trioxalato chromate (III)

c) Nitropentammine cobalt (III) chloride

d) Potassiumhexathiocyanato chromate (III)

Note: Any suitable experiment may be added

Reference Books

1. A text book of Quantitative Inorganic Analysis – A. I. Vogel
2. Advanced Practical Inorganic Chemistry- Gurudeep Raj
3. Practical Inorganic Chemistry- Shikha Gulati, J L Sharma, Shagun Manocha
4. Experimental Inorganic Chemistry - W. G. Palmer
5. The analysis of minerals and ores of the rarer elements – W. R. Schoeller and
6. A.R. Powell, Charles, Griffin and Company Limited

ORGANIC CHEMISTRY PRACTICALS

A) Qualitative analysis: Separation (Ether Separation) and identification of the two component mixtures using Chemical and physical methods. (Minimum 6 mixtures) Major Experiments (Credits 4)

B) Organic Estimations: Major Experiments (Minimum 3 mixtures) (Credits 2)

1. Determination of percentage of Keto-enol form.
2. Estimation of Ibuprofen.
3. Estimation of Aspirin.
4. Verify Beer-Lamberts Law by Colorimetric method.
5. Any other suitable experiments may be added.

RECOMMENDED BOOKS

1. A text book of practical organic chemistry- A. I. Vogel.
2. Practical organic chemistry- Mann and Saunders.
3. A handbook of quantitative and qualitative analysis- H. T. Clarke.
4. Organic Synthesis Collective Volumes by Blat.

PHYSICAL CHEMISTRY PRACTICALS

Physical Chemistry Students are expected to perform 15-20 experiments of three and half-hours duration. Experiments are to be set up in the following techniques.

Potentiometry

1. To determine the instability constant and stoichiometry of silver ammonia complex potentiometrically.
2. Determination of binary mixture of halides.
3. Dissociation constant of acetic acid.

Conductometry

4. Titration of ternary acid mixture of acids.
5. Verification of Onsagar Equation for 1:1 type strong electrolyte.
6. Determination of ΔG, ΔH, ΔS of silver benzoate by solubility product method.

Refractometry

7. Determination of atomic refractions of H, C and Cl atoms.
8. Determination of composition of mixture of liquids.

Chemical kinetics

9. Kinetics of iodination of acetone in presence of strong acid Phase Equilibrium
10. To construct phase diagrams for ternary system.

Viscosity

11. Determination of radius of sucrose molecules. (New experiments may be also be added)

Latent heat of fusion

12. To determine the latent heat of fusion of solid.

Phase Diagram

13. To construct the phase diagram for ternary system.

Reference books

1. Findlay's Practical Chemistry – Revised by J.A. Kitchner (Vedition)
2. Text Book of Quantitative inorganic analysis: A.I. Vogel.
3. Experimental Physical Chemistry: R.C. Das and B. Behera
4. Practical Physical Chemistry : B. Viswanathan and P.S. Raghavan
5. Experimental Physical Chemistry: V.D. Athawale and Parul Mathur.
6. Systematic Experimental Physical Chemistry: S.W. Rajbhoj and T.K. Chondhekar

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