

Department of Chemistry
Islamic University of Science and Technology

Overview of the Course Scheme
First Semester

Semester	Course Code	Course Title	Course Type	Maximum Marks			Credit Distribution			Credits	Total Credits
				Internal*	Final	Total	L	T	P		
I	CHM501C	Metal-Complexes and Reaction Mechanism	Core	50	50	100	3	1	0	4	22
	CHM502C	Stereochemistry and Reaction Intermediates	Core	50	50	100	3	1	0	4	
	CHM503C	Quantum Chemistry and Thermodynamics	Core	50	50	100	3	1	0	4	
	CHM504C	Introduction to Spectroscopic Methods	Core	50	50	100	3	1	0	4	
	CHM505C	Laboratory Course in Physical Chemistry	Core	50	50	100	0	0	2	2	
	CHM506C	Laboratory Course in Inorganic Chemistry	Core	50	50	100	0	0	2	2	
	CHM507E	Mathematics for Chemists	Discipline Centric	25**	25	50	2	0	0	2	
	CHM508E	Green Chemistry	Discipline Centric	25**	25	50	2	0	0	2	

*(Midterm 30 marks + Assignment 10 marks + Attendance 10 marks)

** (Midterm 15 marks + Assignment 5 marks + Attendance 5 marks)

A total of 22 credits to be taken by students with following breakup:

Core =20 Credits

Discipline Centric =2 Credits

Overview of the Course Scheme
Second Semester

Semester	Course Code	Course Title	Course Type	Maximum Marks			Credit Distribution			Credits	Total Credits
				Internal*	Final	Total	L	T	P		
II	CHM551C	Metal Clusters and Electronic Spectra of Metal Complexes	Core	50	50	100	3	1	0	4	24
	CHM552C	Mechanism of Organic Reactions	Core	50	50	100	3	1	0	4	
	CHM553C	Quantum Chemistry, Kinetics and Statistical Thermodynamics	Core	50	50	100	3	1	0	4	
	CHM554C	Chromatographic Techniques	Core	50	50	100	3	1	0	4	
	CHM555C	Laboratory Course in Organic Chemistry	Core	50	50	100	0	0	2	2	
	CHM556C	Laboratory Course in Analytical Chemistry	Core	50	50	100	0	0	2	2	
	CHM557E	Bioinorganic Chemistry	Discipline Centric	25**	25	50	2	0	0	2	
	CHM558E	Conducting Polymers	Discipline Centric	25**	25	50	2	0	0	2	
	Choose from the list of Open Elective courses of other Departments	Open elective	25**	25	50	2	0	0	2		

*(Midterm 30 marks + Assignment 10 marks + Attendance 10 marks)

** (Midterm 15 marks + Assignment 5 marks + Attendance 5 marks)

A total of 24 credits to be taken by students with following breakup:

Core = 20 Credits

Discipline Centric = 2 Credits

Open Elective = 2 Credits

Overview of the Course Scheme
Third Semester

Semester	Course Code	Course Title	Course Type	Maximum Marks			Credit Distribution			Credits	Total Credits
				Internal*	Final	Total	L	T	P		
III	CHM601C	Organometallic chemistry	Core	50	50	100	3	1	0	4	26
	CHM602C	Pericyclic Reactions and Organic Photochemistry	Core	50	50	100	3	1	0	4	
	CHM603C	Electrochemistry and Solid State Chemistry	Core	50	50	100	3	1	0	4	
	CHM604C	Chemical, Thermal and Electroanalytical Methods of Analysis	Core	50	50	100	3	1	0	4	
	CHM605C	Advanced Laboratory Course	Core	50	50	100	0	0	4	4	
	CHM606E	Spectroscopy of Organic Compounds	Discipline Centric	50	50	100	3	0	0	3	
	CHM607E	Spectroscopy of Inorganic Compounds	Discipline Centric	50	50	100	3	0	0	3	
	CHM608E	Chemoinformatics	Discipline Centric	50	50	100	3	0	0	3	

*(Midterm 30 marks + Assignment 10 marks + Attendance 10 marks)

A total of 26 credits to be taken by students with following breakup:

Core = 20 Credits

Discipline Centric = 6 Credits

Overview of the Course Scheme
Fourth Semester

Semester	Course Code	Course Title	Course Type	Maximum Marks			Credit Distribution			Credits	Total Credits
				Internal*	Final	Total	L	T	P		
IV	CHM651C	Advanced Inorganic Chemistry	Core	50	50	100	3	1	0	4	22
	CHM652C	Advanced Organic Chemistry	Core	50	50	100	3	1	0	4	
	CHM653C	Advanced Physical Chemistry	Core	50	50	100	3	1	0	4	
	CHM654C	Polymers and Nanotechnology	Core	50	50	100	3	1	0	4	
	CHM655C	Project and Dissertation	Core	50	50	100				4	
		Choose from the list of Open Elective courses of other Departments	Open Elective	25**	25	50	2	0	0	2	

*(Midterm 30 marks + Assignment 10 marks + Attendance 10 marks)

***(Midterm 15 marks + Assignment 5 marks + Attendance 5 marks)

A total of 22 credits to be taken by students with following breakup:

Core =20 Credits

Open Elective=2 Credits

Semester-I

First Semester
Core Course
Course Title: Metal-Complexes and Reaction Mechanism
Course Code: CHM501C

Credits = 4
M.M. = 100

Unit I: Metal-Ligand Bonding

Brief review of Valence bond theory, Bent rule and energetics of hybridization, VSEPR Theory- shapes of trigonal bipyramidal, Octahedral and pentagonal bipyramidal molecules/ions (PCl_5 , VO_3^- , SF_6 , $[\text{SiF}_6]^{2-}$, $[\text{PbCl}_6]^{2-}$ and IF_7), Limitations of VSEPR theory.

Crystal field theory (CFT), Salient features, Spectrochemical series, Splitting of d-orbitals in octahedral, square planar and tetrahedral geometry, Applications of CFT: Colors of transition metal complexes, Magnetic properties of octahedral complexes, Jahn-Teller distortion, Factors affecting crystal field stabilization energy (CFSE), Limitations of CFT, Experimental evidence for metal-ligand covalent bonding in complexes, Nephelauxetic effect, Ligand field theory.

Unit II: Molecular Orbital Theory and Stability of Transition Metal Complexes

Molecular orbital theory of bonding in octahedral complexes: Composition of ligand group orbitals, Molecular orbitals and energy level diagram for sigma bonded ML_6 , Effect of pi-bonding.

Molecular orbital and energy level diagram for tetrahedral and square planar complexes.

Step-wise and overall formation constant and their relationship, Trends in step-wise constant (kinetic and thermodynamic stability) of metal complexes, Factors affecting the stability of metal complexes with reference to the nature of the metal ion and ligand, Chelate effect, Macrocyclic effect, their thermodynamic origin, Determination of binary formation constant by pH metry and spectrophotometry.

Unit III: Reaction Mechanism in Octahedral Transition Metal Complexes

Reactivity of metal complexes, Inert and labile complexes, Kinetic application of valence bond and crystal field theories, Kinetics of octahedral substitution, Acid hydrolysis, Factors affecting acid hydrolysis, Base hydrolysis, Conjugate base mechanism, Direct and indirect evidences in favour of conjugate mechanism, Anation reactions, reactions without metal ligand bond cleavage.

Unit IV: Reaction Mechanism in Square Planar Complexes and Redox Reactions

Substitution reactions in square planar complexes, Trans-effect, Mechanism of substitution reaction, Factors affecting the rate of substitution- entering and leaving group, Nucleophilicity of entering group.

Redox reactions: Complementary and non-complementary reactions, Classification as outer sphere and inner sphere redox reactions, Mechanism of outer sphere and inner sphere electron transfer reactions- the elementary steps involved, Formation of precursor and successor complexes, Rate laws, Characterization of redox processes as outer and inner sphere.

Factors affecting the rate of electron transfer-Chemical activation, Sigma and pi nature of donor/ acceptor orbitals, electron configuration of oxidant/reductant, Bridging ligand effect in inner sphere reactions.

Books Recommended:

1. Inorganic Chemistry, J. E. Huhey, Harpes & Row. 4th Edn. 2008.
2. Principles of inorganic chemistry; B. R. Sharma, L. R. Sharma, K. C. Kalia; thomos press(India) limited 2010.
3. Inorganic Chemistry; G.L. Miessler & D. A. Tarr; 3rd Edn; Pearson Edn Inc; 2004.
4. Coordination Chemistry; Ajay Kumar; 2nd Edn ; Aaryush Education; 2014.
5. Inorganic Chemistry; Shriver & Atkins; 5th Edn; Oxford University Press; 2010.
6. Reaction Mechanism of Inorganic and Organometallic Systems; R. B. Jordan; Oxford; 3rd Edn.; 2007.
7. Comprehensive Coordination Chemistry eds., G. Wilkinson, R. D. Gillars and J. A. Mc Clevert, Pergamon. 2nd Edn. 2003.
8. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, John Wiley 6th Edn, 1999.
9. Chemistry of the Elements, N. N. Greenwood and A. Earnshaw, Pergamon. 2nd Edn, 1997.
10. Inorganic Electronic Spectroscopy, A. B. P. Lever, Elsevier. 2nd Edn, 1997.
11. Inorganic and Organometallic Reaction Mechanisms; 2nd edn.; Jim D. Atwood; Wiley; 1997
12. Mechanisms of Inorganic Reactions; D. Katakis, G. Gordon; Wiley; 1987.
13. Magnetochemistry, R. L. Carlin, Springer Verlag, 1986.
14. Inorganic Chemistry; K. F. Purcell, L. C. Kotz; Saunders; 1977.
15. Electronic Spectra of Transition Metal Complexes; D. Sutton; McGraw Hill; 1968.
16. Mechanisms of Inorganic Reactions; F. Basolo, R.G. Pearson; Wiley; 2nd Edn.; 1967.

First Semester
Core Course
Course Title: Stereochemistry and Reaction Intermediates
Course Code: CHM502C

Credits = 4

M.M = 100

Unit I: Nature of Bonding in Organic Molecules

Bonding in organic compounds. Review and recapitulation of some basic concepts (Inductive effect, Resonance effect, Hyperconjugation, Cross-conjugation, Electromeric effect. Aromaticity in benzenoid and non-benzenoid compounds, Huckel's rule of aromaticity, Annulenes, Antiaromaticity, Homoaromaticity, molecular orbital approach (Frost diagrams). NMR interpretation of aromaticity. Inclusion compounds-cyclodextrins, Catenanes and rotaxanes, Fullerenes.

Unit II: Reaction Intermediates and Mechanism

Carbocations: Structure and stability, Classical and non-classical, Stability and reactivity of bridge-head carbocations.

Carbanions: Generation, structure and stability.

Radical: Generation, structure, stability and reactions, Cage-effects, Radical-cations and radical-anions.

Carbenes: Formation and structure, Reactions involving carbenes and carbenoids.

Nitrenes: Generation, Structure and reactions of nitrenes.

Arynes: General methods of generation and reactivity.

Reaction Mechanism and its determination: Types of reactions, general methods of determining reaction mechanism (kinetic and thermodynamic requirements, structure of products, isotopic labeling, stereochemical evidence, kinetic isotope effects), transition states and intermediates, Hammond postulate.

Unit III: Stereochemistry

Optical activity and chirality, Molecules with more than one chiral center, Erythro- and threo isomers. Methods of resolution, Optical purity. Fischer's projection formula. Convention for assigning D, L and R, S notation of chiral molecules with one, two and multiple chiral centers, biphenyls and allenes. Study of dissymmetry of allenes, Biphenyls, Spiro compounds. Chirality due to helical shape (Trans-cyclooctene and cyclononene). Asymmetric synthesis, Cram's rule. Enantiotopic and diastereotopic atoms, Groups and faces, Stereochemistry of the compounds containing nitrogen and sulfur.

Unit IV: Conformational Analysis

Conformational analysis of mono, di and tri-substituted cyclohexanes and their stereochemical features (geometrical and optical isomerism), Conformation and reactivity of substituted cyclohexanes, cyclohexanol (Oxidation and Acylation) and cyclohexanone (Reduction). Conformation and stereochemistry of cis and trans-decalin and 9-methyldecalin, Interconversion of sawhorse, Newman and Fischer projections.

Books Recommended:

1. Advanced Organic Chemistry, Reactions, Mechanism and Structure, Jerry March, John Wiley. 7th Edn.; 2013
2. Organic Chemistry, Paula Yurkanis Bruce, Pearson; 7 edition (29 December 2012).
3. Stereochemistry of Organic Compounds, D. Nasipuri. 3rd Edn. 2011
4. Advanced Organic Chemistry, J. Singh and L. D. S. Yadav, Pragati Prakashan. Meerut India, Ed., 2011.
5. Advanced Organic Chemistry; F. A. Carey and R. J. Sundberg; Springer Plenum; 5th Edn.; 2007.
6. Organic Chemistry by I. L. Finar Vol-I and II, ELBS Publications. 6th Edn.; 2002.
7. A Guide Book to Mechanism in Organic Chemistry; Peter Sykes; Longman; 6th Edn.; 1996
8. Organic Chemistry, R. T. Morrison & R. N Boyd, Prentice Hall, 6th Edn.; 1992.
9. Carbenes, Nitrenes and Arynes, T. L. Gilchrist and C. W. Rees, Thomas Nelson and Sons Ltd., London. 1971.
10. Fundamentals of Aromaticity, Manzoor Ahmad Rather, Aadil Khursheed, Scimedtech Publishing, 1st Ed, 2018.
11. Organic Chemistry, J. Clayden, N. Greeves and S. Warren. Oxford University Press, 2nd Edition 2016.
12. Organic Chemistry, Joseph M. Hornback, Cengage Learning; 2 edition (January 31, 2005).

First Semester
Core Course
Course Title: Quantum Chemistry and Thermodynamics
Course Code: CHM503C

Credits = 4
M.M=100

Unit I: Quantum Chemistry-I

Operator concept, Quantum mechanical operators (cartesian and spherical polar co-ordinate systems), Schrodinger equation (Time dependent and independent), Properties of quantum mechanical operators, Postulates of quantum mechanics. Particle in a box problem, extension to two and three dimensions, applications. Solution of harmonic oscillator and the rigid rotator problems. Quantum mechanical tunneling

Unit II: Quantum Chemistry-II

Born-Oppenheimer approximation, Solution of the Hydrogen-like atom problem- radial and angular wave functions. Angular momentum and electronic structure of atom, General theory of angular momentum, Eigen functions and eigenvalues of angular momentum operators, Ladder operators, Spin angular momentum, Anti-symmetry and Pauli's principle. Atomic term symbols, Term separation of p^n and d^n configurations, Spin-Orbit coupling, Zeeman splitting.

Unit III: Classical Thermodynamics

Brief review of concepts of laws of thermodynamics. Entropy and entropy change, Helmholtz and Gibbs free energy, Change in free energy, Gibbs-Helmholtz equation. Partial molar properties, Partial molar free energy and chemical potential, partial molar volume and partial molar heat content and their significances, Determination of these quantities, Concept of fugacity and determination of fugacity. Application of phase rule to two component systems, eutectics.

Unit IV: Interface Thermodynamics

Liquid Surface: Surface tension, pressure difference across curved surfaces (Laplace equation), vapor pressure of droplets (Kelvin equation), Capillary condensation, Solid liquid interface: Contact angle, Young's equation. Wetting, wetting as contact angle phenomena, Thermodynamics of Interfaces: Surface excess, surface tension and thermodynamic parameters, Gibbs adsorption isotherm. Solid surfaces: Adsorption at solid surfaces, adsorption models, Langmuir adsorption isotherm, BET adsorption isotherm and its use in estimation of surface area, Adsorption on porous solids.

Books Recommended:

1. Quantum Chemistry, D. A. McQuarie, Viva Books Pvt Ltd, Student Edn. 2018
2. Quantum Chemistry- Ira. N. Levine, Prentice Hall, 7th Edn.; 2013.
3. Quantum Chemistry, Prasad, New Age Publishers, 4th Edn.; 2010.
4. Introduction to Quantum chemistry; A. K. Chandra; Tata McGraw Hill; 1998.
5. Physical Chemistry- P. W. Atkins, Oxford University Press, 8th Edn.; 2006.
6. Physical Chemistry- A Molecular Approach- D. A. McQuarie & J. D. Simons, 1997.
7. Physics and Chemistry of Interfaces, H-J, Butt, K. Graf and M. Kappl, 2nd Edn, Wiley- VCH, 2006.
8. Physical Chemistry of surfaces, A. W. Adamson, A. P. Gast, John Wiley, 6th Edn., 1987

**First Semester
Core Course
Course Title: Introduction to Spectroscopic Methods
Course Code: CHM504C**

Credits = 4
M.M = 100

Unit I: Statistical Methods

General introduction: Instrumental and non-instrumental methods of analysis in analytical chemistry. Errors in chemical analysis, Classification of errors, Determinate and indeterminate errors, Accuracy and precision, Mean, Median, Average deviation and standard deviation, Confidence limit, Correlation coefficient and regression analysis, Comparison of methods: F-test and T-test, Rejection of data based on Q-test, Grubs test, Least squares method for deriving calibration graph, Concepts and difference between sensitivity, (LOD) and (LOQ).

Unit II: Microwave and IR Spectroscopy

Introduction to spectroscopy, Interaction of light with matter, Peak position, Peak intensity and peak width. Principle of microwave spectroscopy, Classification of molecules, Rigid-rotor model, Effect of isotopic substitution on the transition frequencies, Intensities, non-rigid rotor, Stark effect and applications, Principle of IR, Modes of vibration in molecules, Zero point energy, Force constant and bond strength, Morse Potential energy diagram, Anharmonicity, Derivation of selection rules for diatomic molecules based on harmonic oscillator approximation, Characteristic vibrational frequencies of various functional groups (group frequencies and fingerprint region), Effects of hydrogen bonding and solvent effect on vibrational frequencies, Overtones, Combination bands and Fermi resonance.

Unit III: Raman and UV-Visible Spectroscopy

Classical and quantum theories of Raman effect, Pure rotational, Vibrational and vibrational-rotational Raman spectra, Selection rules, Principle of UV-Vis spectroscopy, Beer-Lambert's Law and derivation, Additivity of absorbance, Factors causing deviations from Beer's law, Electronic excitations, involving π , σ and n-electrons, Chromophores and auxochromes, shifts in UV spectroscopy (Electron donating, Electron withdrawing, Conjugation and extended conjugation), Instrumentation: Single and double-beam spectrophotometers.

Unit IV: NMR spectroscopy

Principle and theory, Nuclear spin, Saturation, Shielding of magnetic nuclei, Chemical shift and its measurement, Factors influencing chemical shift, Spin-spin splitting, Coupling constant (Factors effecting Coupling constant "J") Effect of solvent, Proton and Deuterium exchange, Applications to simple molecules (substituted aliphatic and aromatic compounds).

Books Recommended:

1. Quantitative Chemical Analysis; Daniel Harris, Freeman 9th Edn.; 2016
2. Introduction to Spectroscopy, Pavia, Cengage Learning India Pvt Ltd, New Delhi, 5th Edn.; 2015
3. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West, Holt Rinehart and Winston Publications, 4th Edn.; 2014.
4. Analytical Chemistry by G. D. Christian, John Wiley & Sons Inc, Singapore., 7th Edn.; 2013.
5. Principles of Instrumental Analysis, Skoog, Holler, Nieman, 6th Edn.; 2006
6. Spectrometric Identification of Organic Compounds Robert M. Silverstein, John Wiley, 7th Edn; 2005.
7. Introduction to Instrumental analysis: R. D Braun (Tata McGraw-Hill), 1987
8. NMR in Chemistry, MacMillan Ltd, W. Kemp, 1986.
9. Instrumental Methods of Chemical Analysis, G. W. Ewing, McGraw Hill Pub, 5th Edn.; 1985.
10. Fundamentals of Molecular Spectroscopy, C.N. Banwell, E. M. Mccash, Tata McGraw Hill Pub, 4th Edn. 1994.

First Semester
Core Course
Course Title: Laboratory Course in Physical Chemistry
Course Code: CHM505C

Credits = 2
M.M. = 100

Potentiometry

1. Determination of strength of an acid by titration with an alkali
2. Determination of pK_a value of a weak acid

Polarimetry

3. Determination of the specific rotation of an optically active compound and determination of unknown concentration from the calibration curve.
4. Determination of the rate constant of inversion of cane sugar catalysed by HCl.

Calorimetry

5. Determination of heat of neutralization of a strong acid with a strong base.
6. Determination of heat of neutralization of a weak acid with a strong base.

Spectrophotometry

7. Establishing the validity of Beer-Lambert law.
8. Determination of composition of a binary mixture through spectrophotometry.
9. Spectrophotometric titration of Fe (II) vs $KMnO_4$.

Chemical Kinetics

10. Study of the saponification of an ester and to find the order of the reaction and the rate constant.
11. Determination of order of reaction between $K_2S_2O_8$ and KI by Initial rates method.

Viscometry

12. To find the viscosity of a given liquids at different concentration's and hence to find the unknown concentration.
13. To find the radius of the molecule of a liquid.

Books Recommended:

1. Experiments in Physical Chemistry, Schoemaker et al., MGH, 8th Edn.; 2011
2. Experimental Physical Chemistry, Arthur M. Halpern, George C. McBane, Freeman, 3rd Edn.; 2006.
3. Advanced Practical Physical Chemistry, Yadav, Goel Pub, 1994.
4. Chemistry Experiments for Instrumental Methods, Sawyer, Heineman, Beebe, Wiley, 1984.
5. Findley's Practical Physical Chemistry, B.P. Levitt, 1973.

First Semester
Core Course
Course Title: Laboratory Course in Inorganic Chemistry
Course Code: CHM506C

Credits = 2
M.M. = 100

Qualitative Analysis

1. Analysis of two cations and anions (macro analysis of elements).
2. Identification of cations including those of less common elements using semi-micro technique.

Separation and estimation of following binary metal ion system using Gravimetry and Titrmetry

3. Cu-Ni: Estimation of both by gravimetric method
4. Ag-Cu, Estimation of Ag gravimetrically and Cu volumetrically
5. Cu-Zn: Estimation of both by gravimetric method
6. Cu-Fe: Estimation of both by gravimetric method
7. Ca-Mg: Estimation of both by titrating against EDTA solution
8. Zn-Mg: Estimation of both by titrating against EDTA solution

Preparations of Coordination compounds of transition metals

- Theoretical appraisal of first row transition metal coordination chemistry.
 - Synthesis as a Laboratory technique (Concepts, Calculations and Design of Synthetic procedures)
 - Preparation of selected inorganic compounds.
9. $[\text{Cu}(\text{NH}_3)_4] \text{SO}_4 \cdot \text{H}_2\text{O}$
 10. $\text{cis-K}[\text{Cr}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})_2] \cdot 2\text{H}_2\text{O}$
 11. $\text{K}_3[\text{Cr}(\text{C}_2\text{O}_4)_3] \cdot 3\text{H}_2\text{O}$
 12. $[\text{Co}(\text{en})_2(\text{C}_2\text{O}_4)]\text{Cl} \cdot \text{H}_2\text{O}$
 13. $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)](\text{NO}_2)_2$
 14. $\text{trans-}[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$
 15. $\text{Ni}(\text{en})_3\text{Cl}_2$
 16. $\text{Ni}(\text{acac})_2$
 17. $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$
 18. $\text{Ni}(\text{dmg})_2$

Separation and Identification of following given mixtures by paper/thin layer chromatography

19. Ni (II) and Co (II).
20. Co (II) and Ni (II).
21. Cu (II), Ni (II) and Co (II).

Books Recommended:

1. Quantitative Chemical Analysis; Daniel Harris, Freeman 9th Edn.; 2016.
2. Inorganic syntheses, Thomas B. Rauchfuss, Vol. 35. Wiley, 2010
3. Advanced Experimental Inorganic Chemistry; Ayodha Singh; Campus Books, 2002.
4. Vogel's Quantitative Analysis Mendham, Denny; Pearson Education, 6th Edn.; 2000
5. Synthesis and Technique in Inorganic chemistry, G. S. Grlomi; R. J. Angleci; University Science Books. 3rd Edn.; 1999.
6. Experimental Inorganic / Physical Chemistry; Mounir A. Malati Horwood/1999.
7. The Synthesis and Characterization of Inorganic compounds W. A Jolly, 3rd Edn.; 1990
8. Advanced Practical Inorganic Chemistry; Adams; Raynor, Wiley; 1965.
9. Thin Layer Chromatography, A laboratory handbook, E. Stahl, Springer Verlag, 2nd Edn.; 1965.

First Semester
Discipline Centric Course
Course Title: Mathematics for Chemists
Course Code: CHM507E

Credits = 2

M.M = 50

Unit I: Probability and Vectors

Probability: Variables, Discrete and continuous, Sample space, Event probability, Fundamental counting principles: Permutations and combinations, Binomial probabilities, Probability distribution functions, Probability involving discrete and continuous variables, Average values, Distribution moments and variance.

Vectors: Vectors, Dot, Cross and triple products with applications.

Unit II: Determinants and Matrix Algebra

Determinants, Basic concepts, Types and properties

Matrices: Rectangular, Square, Diagonal & triangular matrices, Trace of a matrix, Addition and multiplication of matrices, Zero & identity matrix, Transpose, Adjoint & inverse of matrices, Special matrices (Symmetric, Skew-symmetric, Hermitian, Skew-Hermitian, Unitary matrices.)

Matrix equations: Homogeneous and non-homogeneous linear equations and conditions for their solutions, Eigen-value problem

Unit III: Calculus (Differentiation and Integration)

Functions and their continuity and differentiability, Rules for differentiation, Applications of differential calculus including maxima and minima finding (Examples: Maximally populated rotational levels, Bohr's radius, Most probable velocity from Maxwell distribution), Integration, Basic rules for integration, Integration by substitution, Integration by parts, Applications of integral calculus (Kinetics: zero, first, second order reactions)

Unit IV: Elementary Differential Equations

Partial differentiation, Co-ordinate transformations (Cartesian to spherical polar co-ordinates). Order and degree of differential equations, Homogeneous and non-homogeneous equations. Variable-separable equations: Linear first order differential equations and its solutions. Second order differential equations, Solution by auxiliary equation method. (Applications to quantum chemistry).

Books Recommended:

1. Physical Chemistry; Thomas Engel & Philip Reid; Pearson Education 3rd Edn.; 2013
2. Mathematics for Physical Chemistry; R. G. Mortimer; Elsevier; 4th Edn.; 2013.
3. The Chemistry Mathematics Book; E. Steiner; Oxford; 2nd Edn.; 2008.
4. Mathematical Method in Physical Science; M. L. Boas, John Wiley and Sons; 3rd Edn.; 2005.
5. Mathematical Methods for Scientists and Engineers; D. A. McQuarrie; Viva Books Pvt Ltd.; 2009.
7. Basic Mathematics for Chemists; Tebbutt; Wiley; 2nd Edn.; 1998
9. Mathematical Techniques in Chemistry; J. B. Dence; Wiley; 1975.
10. Mathematics for Chemists; C. L. Perrin; Wiley; 1971.

First Semester
Discipline Centric Course
Course Title: Green Chemistry
Course Code: CHM508E

Credits = 2
M.M. = 50

Unit I: Principles and Concept of Green Chemistry

Concept and principles, Development of green chemistry- atom economy reactions, Rearrangement reactions, Addition reactions, Atom uneconomic-sublimation elimination-wittig reactions, Toxicity measures, Need of green chemistry in our day to day life.

Unit II: Environmental Performance

Importance of measurement, Lactic acid production, Safer gasoline, Introduction to life cycle assessment, Four stages of life cycle assessment (LCA), Carbon foot printing-green process, Matrics, Eco labels- integrated, Pollution, Prevention and control (IPPC)-REACH (Registration, Evaluation, Authorization of Chemicals).

Unit III: Green Energy Process

Design for energy efficiency, Photochemical reactions, Advantages, Challenge faced by photochemical process, Microwave technology on chemistry, Microwave heating, Microwave assisted reactions, Sono chemistry and Green chemistry, Electrochemical synthesis-examples of electrochemical synthesis.

Unit IV: Renewable Resources

Biomass, Renewable energy, Fossil fuels, Energy from biomass, Solar power, Other forms of renewable energy-Fuel-Cells, Alternative economics, Syngas economy, Hydrogen economy, Bio-refinery chemicals from fatty acids, Polymer from renewable resources, Some other natural chemical resources.

Books Recommended:

1. Green Chemistry in Pharmaceutical Industry, P. J. Dunn. A. Wells, M. T. Williams, Wiley VCH, 2010.
2. Green Chemistry- An Introductory Text; M. Lancaster, RSC Publishing, 2nd Edn.; 2010
3. Green Chemistry; Samuel Delvin; IVY Publishing House; 1st Edn.; 2008.
4. Methods and Reagents of Green Chemistry: An Introduction, P. Tundo (Editor), A. Perosa, F. Zecchini, 2007.
5. Green Chemistry- Environment Friendly Alternatives; Rashmi Sangh & M. M Srivastava; Narosa, 2007.
6. Green Chemistry– Environment Benign Reactions, V. K. Ahluwalia, CRC Press, 2007
7. Green Chemistry theory and Practice, P. T. Anastas and J. C. Warner, Oxford University Press, 2000
8. Stream Lined Life-Cycle assessment, T. E. Graedel, Prentice Hall, New Jersey, 1998.

Semester-II

Second Semester
Core Course
Course Title: Metal Clusters and Electronic Spectra of Metal Complexes
Course Code: CHM551C

Credits = 4
M.M. = 100

Unit I: Pi-Acid Complexes

Metal carbonyls, Structure and bonding, Dative overlap, Back-bonding ($p\pi-d\pi$) synergic interaction, Bonding and structural elucidation of metal carbonyls by IR and NMR, Important reactions of metal carbonyls, Identification of metal carbonyl isomers by IR active bands, Preparation, bonding, structure and important reactions of transition metal nitrosyl complexes. Nature and bonding of dinitrogen and dioxygen complexes.

Unit II: Metal Clusters

Occurrence and classification of metal clusters, Pre-requisites for the formation of metal-metal bond, Trinuclear compounds, Tetranuclear clusters, Polynuclear compounds, Lower halides and oxides, Metal only clusters, Bonding in metal clusters, Metal carbonyl and metal carbonyl halide clusters, Structure and bonding of compounds with metal-metal multiple bonds, Islobal analogy, Structure of some carbonyl metallocenes.

Unit III: Electronic Spectra and Magnetic Properties of Transition Metal Complexes

Spectroscopic ground states, Correlation (for d^2 system), Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), Calculations of Dq , B and β parameters, Charge transfer spectra, Types of magnetic bodies, orbital and spin effect, Curie equation and Curie Weiss law, Determination of magnetic susceptibility, Quenching of orbital Contribution, Anomalous magnetic moments, Magnetic exchange coupling and spin crossover.

Unit IV: Symmetry and Group theory

Symmetry elements and operations, Combination of symmetry operations, Groups, Subgroups, Classes, Group multiplication tables, Symmetry point groups, Identification of point groups, Systematic procedure for assignment of point groups to molecules, Symmetry classes and their geometrical significance reducible, Representations and Irreducible representations, Great orthogonality theorem (GOT), Character table (C_{2v} , C_{3v} , C_{2h}).

Books Recommended:

1. Symmetry and Spectroscopy of Molecules, K. Veera Reddy, 2nd Edn.; 2009
2. Symmetry Through the Eyes of a Chemist, I. Hargittai and M. Hargittai, 3rd Edn.; 2009
3. Inorganic Chemistry; G.L. Miessler & D. A. Tarr; 3rd Edn; Pearson Edn Inc; 2004.
4. Basic organometallic Chemistry; B. D. Gupta, A J Elias; 2nd Edn; University press 2013.
5. Inorganic Chemistry, J. E. Huhey, Harpes & Row. 4th Edn.; 2008.
6. Comprehensive Coordination Chemistry G. Wilkinson, R. D. Gillars and J. A. M. Clevert, 2nd Edn.; 2003.
7. Advanced Inorganic Chemistry, F. A. Cotton and G. Wilkinson, John Wiley 6th Edn.; 1999.
8. Symmetry and Group Theory In Chemistry, Mark Ladd, Harwood Publishers, London, 1st Edn.; 1998
9. Chemistry of the Elements, N. N. Greenwood and A. Earnshaw, Pergamon. 2nd Edn.; 1997
10. Inorganic Electronic Spectroscopy, A. B. P. Lever, Elsevier. 2nd Edn.; 1997
11. Molecular Symmetry and Group Theory, Robert L. Carter, John Wiley & Sons, 1997
12. Group Theory for Chemists, G. Davidson, Macmillan Physical Science Series, 1st Edn.; 1991.
13. Chemical Applications of Group Theory, F. A. Cotton, Wiley NY, 3rd Edn.; 1990
14. Magnetochemistry, R. L. Carlin, Springer Verlag, 1986

Second Semester
Core Course
Course Title: Mechanism of Organic Reactions
Course Code: CHM552C

Credits = 4
M.M = 100

Unit I: Substitution Reactions:

Review and recapitulation: Aliphatic nucleophilic: S_N1 , S_N2 , Walden inversion, Mixed S_N1 , S_N2 , S_NI and SET mechanisms, Effect of leaving group and solvent. Substitution at allylic, benzylic and vinylic carbon atoms. Aromatic electrophilic: The Arenium ion mechanism, Energy profile diagrams, ortho/para and meta-directing groups. Ipso attack, Vilsmeier, Gatterman-Koch, Reimer-Tiemann reactions, Diazonium coupling. Aromatic nucleophilic: Introduction to different mechanisms of aromatic nucleophilic substitution, S_NAr . Benzyne mechanism.

Unit II: Elimination Reactions

Competition between substitution and elimination reactions. The E_1 , E_2 and E_1CB mechanisms and orientation of the double bond. Saytzeff and Hoffman's rule. Effect of substrate structure, attacking base, leaving group and medium. Stereochemistry of elimination reactions, elimination in cyclic systems. Mechanistic insights of some elimination reactions: Hydro-alkoxy-elimination, *epi*-oxy-elimination, Chugaev elimination, Hoffman elimination, Cope's elimination, Shapiro reaction, Bamford-Stevens reaction, Corey-Winter reaction.

Unit III: Addition Reactions

Addition to carbon-carbon multiple bond: Addition reaction involving electrophiles, Markownikov's and anti-Markownikov's rule (Peroxide effect), Nucleophiles and free radicals, Addition to cyclopropanes, Hydrogenation of double bond and triple bonds. Hydrogenation of aromatic rings, Hydroboration, Michael addition. **Addition to carbon-hetero multiple bonds:** Overview of reactive carbonyl compounds, Mechanisms of addition of H_2O , HCN, Alcohols, Amines, Addition of Hydrazine, Hydrides to aldehydes and ketones. Mechanism of Wittig, Mannich, Aldol, Cross Aldol, Cannizzaro, Knoevenagel, Robinson annulation, Claisen, Benzoin and Perkin reactions.

Unit IV: Molecular Rearrangement Reactions

Classification and general mechanistic treatment of electrophilic, nucleophilic and free radical molecular rearrangement. Molecular rearrangements in acyclic, monocyclic and bicyclic carbocations. Mechanism of the following rearrangement: Wagner-Meerwin, Pinacol-Pinacolone, Demjanov ring contraction and ring expansion, Benzil-benzilic acid, Favorski, Hoffman, Curtius, Lossen, Schmidt, Beckmann, Baeyer-Villiger.

Books Recommended:

1. Fundamentals of Organic Chemistry; Solomons; Wiley; 12th Edn.; 2015.
2. Organic Chemistry, John McMurry; Brooks/Cole; 9th Edn.; 2015
3. Advanced Organic Chemistry, Reactions, Mechanism and Structure, Jerry March, 7th Edn.; 2013.
4. Organic Chemistry, Paula Yurkanis Bruce, Pearson; 7 Edn.; 2012.
5. Advanced Organic Chemistry; 5th edn.; F. A. Carey and R. J. Sundberg; Springer Plenum; 2007.
6. Organic Chemistry; J. Hornback; Brooks/Cole; 2nd Edn.; 2005.
7. Structure and Mechanism in Organic Chemistry; C. K. Ingold; CBS; 2nd Edn.; 2000.
8. Reaction Mechanism in Organic Chemistry; S. M. Mukherjee and S. P. Singh; Macmillan; 3rd Edn.; 1998.
9. A Guide Book to Mechanism in Organic Chemistry; Peter Sykes; Longman; 6th Edn.; 1996.
10. Organic Chemistry, J. Clayden, N. Greeves and S. Warren. Oxford University Press, 2nd Edn.; 2016.

Second Semester
Core Course
Course Title: Quantum Chemistry, Kinetics and Statistical Thermodynamics
Course Code: CHM553C

Credits = 4
M.M. = 100

Unit I: Quantum Chemistry-III

Variation theorem, Linear variation principle, Application to Hydrogen atom and Helium atom, Perturbation theory-first order (non-degenerate and degenerate), Application of perturbation method to Helium atom, Chemical bonding, LCAO-MO approximation, H_2^+ molecular ion, Brief introduction to H_2 , Molecular term symbols, Valence bond treatment of H_2 , Comparison of MO and VB methods in the light of H_2 molecule, Hybridization of orbitals (sp , sp^2 and sp^3).

Unit III: Chemical Kinetics-I

Kinetic analysis of experimental data: Estimation of order and rate constant from concentration-time data (Differential rate method and Integral rate method).

Fast reactions: General features of fast reactions, Study of fast reactions by flow method, Relaxation method and flash photolysis.

Theories of chemical reactions: Activated complex theory of reaction rates, Statistical and thermodynamic formulations, Comparison with collision theory.

Theories of unimolecular reactions (Lindman, Hinshelwood theories), Potential energy surfaces.

Unit IV: Chemical Kinetics-II

Surface Reactions: Unimolecular & bimolecular surface reactions, Langmuir-Hinshelwood and Langmuir-Riedel mechanism, Classical and Statistical treatments.

Reactions in liquid solutions: Diffusion controlled reactions (partial and full microscopic diffusion control), Ionic reactions: Single and double sphere models of ionic reactions, Hammett equation, Catalysis: introduction to catalysis, Mechanism of catalysis, Use of solvents as catalysts, Enzyme catalysis, Michaelis-Menten Equation, Inhibition, Effects of pH and Temperature on enzyme catalysis reactions.

Unit IV: Statistical Thermodynamics-I

Concept of Distribution, thermodynamic probability and most probable distribution, Sterling approximation, Derivation of Boltzmann distribution law, Bose-Einstein and Fermi-Dirac distribution equations (without derivation). Comparison of M-B, F-D and B-E distribution laws, Partition function and its significance, translational, rotational, vibrational and electronic partition function, Calculation of thermodynamic properties in terms of partition functions, application to ideal monoatomic gas, Equilibrium constant in terms of Partition Functions, Application to dissociation equilibrium.

Books Recommended:

1. Quantum Chemistry, D. A. McQuarrie, Viva Books Pvt Ltd, Student Edn.; 2018.
2. Quantum Chemistry- Ira. N. Levine, Prentice Hall, 7th Edn.; 2013.
3. Quantum Chemistry, Prasad, New Age Publishers, 4th Edn.; 2010 (Reprint 2014).
4. Molecular Quantum Mechanics- P. W. Atkins and R. S. Friedmann, Oxford, 5th Edn.; 2010.
5. Chemical Kinetics, K. J. Laidler, McGraw-Hill, 4th Edn.; Revised, 2002
6. Chemical Kinetics and Catalysis, R. I. Masel, Wiley, 2001.
7. Chemical Kinetics and Dynamics, J. I. Steinfeld, J. S. Francisco, W. L. Hase, 2nd Edn.; 1998.
8. Statistical Thermodynamics, M. C. Gupta, New Age Publishers Pvt Ltd., 2013
9. Statistical Thermodynamics by T. L. Hill, Dover publications, 2012.
10. Statistical Mechanics by D. A. McQuarrie, Viva Books Pvt Ltd, 2018.
11. Physical Chemistry, P. W. Atkins, J. D. Paula, Oxford, 2010

Second Semester
Core Course
Course Title: Chromatographic Techniques
Course Code: CHM554C

Credits = 4
M.M. = 100

Unit I: Thin-Layer Chromatography

General introduction to chromatography, Principle of TLC; Types and selection of stationary phases (adsorbents) and mobile phases, Methods of plate development; Detection of spots; Performance characteristics of thin-layer plates, Retardation and retention factor, Plate heights, 2D TLC and HPTLC, Application

Chiral chromatography: Chiral derivatization, Chiral mobile-phase, Chiral stationary phases, Mechanism of chiral interactions, Applications.

Unit II: Size Exclusion and Ion Exchange Chromatography

Principle; Gels, Theoretical basis, Exclusion limit, Total permeation and selective permeation regions. Relation between elution volume and molecular weight, Molecular weight determination. Fractionation in a complex mixture, Packing materials and applications,

Introduction to ion-exchange chromatography, Types of ion exchange materials, Mechanism of ion exchange, Ion exchange equilibrium, Total, Apparent and volume ion exchange capacity, Ion chromatography. Distinction between ion-exchange and ion chromatography, Ion suppressor Column, Applications of IEC for separation of biological molecules (amino acids).

Unit III: High Performance Liquid Chromatography (HPLC)

Principle, Theory and instrumentation, Plate theory, Rate theory, Van-Deemter-Equation, Resolution, Retention time and other basic parameters, Basic difference between HPLC and conventional liquid-chromatography, Packing materials and equipment, Detectors (UV-Vis, RI, Florescence, electrochemical) , Advantages and Applications, Reverse phase HPLC and normal phase HPLC, Brief Introduction to hyphenated LC-MS technique.

Unit IV: Gas Chromatography

Principle, Instrumentation: Columns and stationary phases, Detectors:- TCD, FID and Electron Capture Detector, Factors affecting the efficiency of the column, Van-Deemter Equation, Qualitative and quantitative analysis based on peak height and peak area, Brief introduction to hyphenated GC-MS technique.

Books Recommended:

1. Analytical Chemistry by G. D. Christian, John Wiley & Sons Inc, Singapore., 7th Edn.; 2013.
2. Gas Chromatography and Mass Spectrometry: A Practical Guide, O David Sparkman, Zelda Penton and Fulton G. Kitson, Elsevier, 2nd Edn.; 2011.
3. Introduction to Modern Liquid Chromatography: L. R. Snyder& J. J. Kirkland (John Wiley & Sons, New York). 3rd Edn.; 2009
4. Chromatography: Concepts and Contrasts, James M. Miller, Wiley, 2nd Edn.; 2009.
5. Principles of Instrumental Analysis, Skoog, Holler, Nieman, 6th Edn.; 2006
6. Principles and Practice of Analytical Chemistry by F. W. Fifield and D. Kealey, Blackwell Science Ltd, New Delhi 5th Edn.; 2004.
7. Handbook of Instrumental Techniques for Analytical Chemistry, Editor, F. Settle, Pearson Education Inc, New Delhi. Low Price Edn, 2004.
8. Instrumental Methods of Analysis, Willard, Merit, Dean and Settle, CBS Publishers and Distributors, 7th Edn.; 2004.
9. Chiral Separations by liquid chromatography and related technologies, Hassan Y. Aboul-Enein, Imran Ali, CRC press, 2003.
10. Chromatography and Separation Science By Satinder Ahuja McGraw Hill Pub, 5th Edn.; 1985.
11. Chromatographic Methods by A.Braithwaite and F.J.Smith by Kluwer Academic Publishers 5th Edn.;1999

Second Semester
Core course
Course Title: Laboratory Course in Organic Chemistry
Course Code: CHM555C

Credits = 2
M.M. = 100

Organic Preparations

1. Preparation of dibenzal acetone from benzaldehyde.
2. Preparation of adipic acid by chromic acid oxidation of cyclohexanol.
3. Preparation of caprolactum.
4. Preparation of phenol formaldehyde resin.
5. Preparation of cinnamic acid by perkin reaction.

Qualitative Analysis.

6. Detection of elements: nitrogen, sulphur and halogens.
7. Detection of functional groups: detection of carbohydrates, Unsaturation, Carboxylic acids, Carbonyl compounds, Phenols, Alcohols, Halides, Amines, Amides, Imides, Ureas, Thioureas, Nitrocompounds and hydrocarbons.
8. Separation and identification of binary organic compounds using physico-chemical methods.

Books Recommended:

1. Organic Chemistry Lab Manual N. S. Gnanapragasam and B. Ramamoorthy, S. Visvanathan Printers & Publishers, 2010.
2. Comprehensive Practical Organic Chemistry; V. K. Ahluwalia and Renu Aggarwal; University Press; 2000
3. Advanced Practical Organic Chemistry; N. K. Vishnoi; Vikas; 2nd Edn.; 1999.
4. Vogel's Textbook of Practical Organic Chemistry; A. R. Tatchell; ELBS; 5th Edn.; 1996.
5. Experiments and Techniques in Organic Chemistry; D. Pasto, C. Johnson and M. Miller; Prentice-hall; 1992.
6. Microscale and Macroscale Organic Experiments; K. L. Williamson; D. C. Heath and Co. 1989.

Second Semester
Core Course
Course Title: Laboratory Course in Analytical Chemistry
Course Code: CHM556C

Credits = 2
M.M. = 100

pH-metry

1. Determination of strength and pKa value of a weak acid by titration with an alkali.
2. Titration of a dibasic acid with alkali to find its pKa values.

Ion Exchange

3. Determination of Ion-exchange capacity of resin (cationic and anionic).
4. Separation of Zn and Cd by ion-exchangers.

Chromatography

5. Column chromatographic separation of cis and trans azobenzene and o- and p- nitroanilines determined spectrophotometrically
6. Separation of amino acids by thin layer and paper chromatography.

Spectroscopy

7. Extraction of caffeine from tea leaves, characterization by IR.
8. Determination of iron in pharmaceutical samples by visible spectrophotometry.

Quantitative analysis

9. Determination of iodine value and saponification value of edible oils.
10. Determination of metal ions by flame photometry (sodium, potassium, sodium and potassium in a mixture).

Synthesis

11. To synthesis polymer based hydrogel and determine its hydration.
12. To synthesize ion exchange material and determine the ion exchange capacity for Na⁺ ions

Books Recommended:

1. Environmental Chemistry, A. K. De, 7th Edn.; 2010.
2. Fundamental of Analytical Chemistry, Skoog and Wesst, 9th Edn, 2014.
3. Practical Pharmaceutical Chemistry, part-2, Beckett, Stenlake, 4th Edn.; 2001.
4. Analytical Chemistry Theory and Practice, R. M. Verma .CBS Publishers & Distributors, 3rd Edn.; 2000.
5. Vogel's Quantitative Analysis Mendham, Denny; Pearson Education 6th Edn.; 2000
6. A textbook of Practical Organic Chemistry, A. I. Vogel, 5th Edn.; 1996.
7. Standard methods of Chemical Analysis, F. J. Welcher, 6th Edn.; 1962.
8. Experiments in Chemistry, D. V. Jagirdar, Himalaya publication.

Second Semester
Discipline Centric Course
Course Title: Bioinorganic Chemistry
Course Code: CHM557E

Credits =2
M.M. = 50

Unit I: Metal ions in Biochemical Systems

Introduction to bio-inorganic chemistry, Concept of essentiality, Criteria and classification of essential elements as per their role in living systems, Bulk metals and trace metals, Role of alkali and alkaline earth metals in biosystems, Metal ion toxicity, Na⁺-K⁺ pump, Transport and storage of Iron (Ferritin, Transferrin and siderophores), Application of radioactive elements for biosystems.

Unit II: Metalloporphyrins and Respiration

Metalloporphyrins, Cytochromes (Cytochromes C, Cytochrome C-oxidase, Cytochrome P-450). Dioxygen transport (haemocyanin and hemoerythrin), Structure and physiological role of hemoglobin and myoglobin, Bohr Effect and cooperativity, Chloride effect.

Unit III: Electron Transport in Biosystems

Electron transport in biosystems, Iron-Sulfur proteins, Ferredoxins, Rubredoxin, Copper proteins, Photosynthesis (PS I and PS II), Z-scheme, Structure of chlorophyll a and b, Superoxide dismutase-A

Unit IV: Enzymes and medicinal Chemistry

Enzymes and co-enzymes, Structure and function of carboxypeptidase A, Carbonic anhydrase, Xanthine oxidase, Vitamin B-12, Nitrogen fixation, Biochemical basis of essential metal deficient diseases and their therapies (Iron, Zinc, Copper and Manganese). Chelate therapy, Anticancer drugs-cisplatin.

Books Recommended:

1. Inorganic Chemistry – Puri, Sharma and Kalia. Milestone publishers, 32nd Edn.; 2014
2. Inorganic Chemistry, J. E. Huhey, Harpes & Row. 4th Edn.; 2008.
3. Bio inorganic Chemistry ; K. Hussain Reddy; New Age International (P) Ltd; 2005.
4. Metal -Ions in Biochemistry; P. K. Bhattacharya; Narosa Publishing House; 2005.
5. Inorganic Chemistry in Biology; Wilkins C & Wilkins G; Oxford; 1997.
6. Principles of Bio inorganic Chemistry; Lippard, Berg; Univ. Science Books; 1994.
7. The Biological Chemistry of Elements; Frausto de Silva; Williams; Clarendon; 1991
8. A Text book of Medicinal aspects of Bioinorganic Chemistry; Das; CBS; 1990.
9. Bio inorganic Chemistry -An introduction; Ochai, Allyn and Bacon; 1977.
10. Inorganic Aspects of Biological and Organic Chemistry; Hanzilik; Academic; 1976
11. Inorganic Bio-chemistry—Vol. 1&2; Eichhorn; Elsevier, 1973.
12. The Inorganic Chemistry of Biological processes; Hughes ; Wiley; 2nd Edn.; 1973.

Second Semester
Discipline Centric Course
Course Title: Conducting Polymers
Course Code: CHM558E

Credits = 2
M.M. = 50

Unit I: Basic Concepts

Basics of conducting polymers, Historical background. Classification of electrochemically active polymers, Redox polymers, Electronically conducting polymers (Intrinsically Conducting Polymers—ICPs), Electronically conducting polymers with built-in or pendant redox functionalities, Copolymers, Composite materials, Applications of conducting polymers.

Unit II: Synthesis

Electrolytic conduction, Electrodes and mechanism; Electrochemical-synthesis of derivatives of poly-pyrrole, Polythiophene, Polyazulene, Polycarbazole, insert inorganic examples.

Unit III: Semiconducting and Metallic Polymers

Introduction and structural basis for semiconducting, metallic polymers and organic meta-polymers- synthetic routes, isomers and electronic structure of polyacetylene, Poly-*p*-phenylene, Polypyrrole, Polythiophene, insert metallic examples

Unit IV: Doping and Catalysis

Introduction, Electrochemical doping, Role of reduction and oxidation potential in doping, Polyacetylene as electrode materials.

Introduction to catalysis, Catalytic properties of conducting polymers, Catalysis of electron donor-acceptor complexes. Electrocatalysis by semiconducting polymers.

Books Recommended:

1. Conducting Polymers; A New Era in Electrochemistry, Gyorgy Inzelt, Springer-Verlag Berlin Heidelberg 2nd Edn.; 2012.
2. Conductive Electroactive Polymers, Wallace Gordon, Gordon G Wallace, Geoffrey M Spinks, CRC Press, 3rd Edn.; 2008
3. Conductive Polymers and Plastics, Larry Rupprecht, Elsevier, 1st Edn.; 2000.
4. Handbook of Conducting Polymers, Terje A. Skotheim, Ronald L. Elsenbaumer, John R. Reynolds, Marcel Dekkar, 2nd Edn.; 1997.
5. Handbook of Organic Conductive Molecules and Polymers, Four Volume Set, Hari Singh Nalwa (Editor), Wiley, 1997.
6. Organic Conductors, Jean-Pierre Farges, Marcel Dekkar, 1994
7. New Concepts in Polymer Science, Polymeric Composites, Raymond B Seymour, VSP, 1990.
8. Electrically Conductive Organic Polymers for Advanced Applications David B Cotts, Z Reyes, 1987.

Semester-III

Third Semester
Core Course
Course Title: Organometallic Chemistry
Course code: CHM601C

Credits = 4
M.M. = 100

Unit I: Sigma bonded Organometallic Compounds

Classification, Stability, Routes of synthesis, Reactions, Structure and bonding. Decomposition pathways: α and β hydrogen transfer. Intramolecular elimination of alkane. Stability from bulky substituents, Agostic alkyls.
Metal hydride complexes: Synthesis, Characterization and Chemical reactions.

Unit II: Pi-bonded Organometallic Compounds

Classification, Synthesis, Structure and bonding in Metal-alkynes, allyls, 1,3-butadiene and cyclobutadiene complexes
Sandwich compounds: General characteristics; Classification, Synthesis, Reactions, Structure and bonding of cyclopentadienyl complexes with special reference to ferrocene.
Compounds with transition metal—carbon multiple bonds, Alkylidene and alkylidyne synthesis, Structural characteristics, Nature of bonding.

Unit III: Catalytic Processes involving Transition Metal Organometallic Compounds

Mechanistic aspects: Oxidative addition, Insertion reactions and reductive elimination. Hydrogenation, Hydroformylation, Oxidation, Isomerization and Zeigler-Natta-- polymerization of alkenes.
C-C coupling reactions- Suzuki and Heck, Grubbs catalyst, Sonogashir, Stille coupling, Activation of small molecules like CO, CO₂ and alkanes.

Unit IV: Fluxional Organometallic Compounds

General characteristics, Rates of rearrangement and techniques of study, Classification of fluxional organometallic compounds, Some simple examples of non-rigid molecules in 4 and 5 coordination geometries, Fluxionality and dynamic equilibria in compounds such as 2-olefin, 3-allyl and dienyl complexes.

Books Recommended:

1. Principles and applications of organotransition metal chemistry, Collman J. P., Hegsdus L. S., Norton J. R. and Finke R. G., University Science Books;1994.
2. Basic organometallic Chemistry; B. D. Gupta, A J Elias; 2nd Edn; University Press; 2013.
3. Organometallic & Bioinorganic Chemistry; Ajai Kumar; 2nd Edn ; Aaryush Education; 2016.
4. The Organometallic chemistry of the transition metals, R. H. Crabtree, John Wiley; 2014.
5. Metallo-organic chemistry, Pearson A.J., Wiley; 1994.
6. Organometallic chemistry, Mehrotra R. C. and Singh A., New Age International; **2007**.
7. Reaction Mechanisms of Inorganic and Organometallic Systems; 3rd Edn.; Jordon; Oxford University Press; 2007.
8. Mechanism of Inorganic Reactions; Katakis, Gordon; Wiley; 1987.
9. Inorganic Chemistry; 4th Edn; Huheey; Harper & Row; 1990.
10. Chemistry of elements, NN Green Wood, Elsevier.

Third Semester
Core Course
Course Title: Pericyclic Reactions and Organic Photochemistry
Course Code: CHM602C

Credits = 4
M.M = 100

Unit I: Pericyclic Reactions-I

General introduction, Definition and classification of pericyclic reactions. Molecular orbital symmetry, Frontier molecular orbital concept (FMO), HOMO, LUMO and SOMO: Frontier molecular orbitals of various π -electron systems including ethene, 1, 3-butadiene, 1,3,5-hexatriene and allylic systems. Woodward Hoffman rules for pericyclic reactions.

Unit II: Pericyclic Reactions-II

Cycloadditions: Thermal and photochemical 2+2 and 4+2 cycloadditions, Suprafacial and antarafacial cycloadditions.

Electrocyclic reactions: Thermal and photochemical electrocyclic reactions of $4n$ and $4n+2$ systems and their stereochemical aspects, Conrotatory and disrotatory motions.

Sigmatropic rearrangements: Classification, [1,3], [1,5] and [3,3] sigmatropic shifts, Cope and Claisen rearrangements, Suprafacial and antarafacial shifts of hydrogen, Biological pericyclic reactions.

Unit III: Photochemistry-I

Types of photochemical excitations, Direct and indirect excitations, The fate of excited molecule, Singlet and triplet states and their lifetimes, Jablonski diagram, Transfer of excitation energy: sensitization and quenching, quantum yield, Different types of photochemical reactions,

Photochemical reactions of alkenes: Geometrical isomerization reactions, Dimerization and cyclization reactions, Photochemical reactions of 1,3-butadiene, Rearrangements of 1,4 and 1,5-dienes, Photochemistry of vision.

Unit IV: Photochemistry-II

Photochemical reactions of saturated cyclic and acyclic carbonyl compounds, Norrish type-I and Norrish type-II reactions, Paterno-Buchi reaction.

Photochemical reactions of α , β -unsaturated carbonyl compounds (H-abstraction and isomerization to β,γ -unsaturated carbonyl compounds).

Light induced isomerizations of benzene and its alkyl derivatives, Nucleophilic photosubstitution reactions of aromatic compounds, Photo-Fries rearrangement of aryl esters and anilides. Photolysis of organic nitrites.

Books Recommended:

1. Introductory Photochemistry, A. Cox and T. Kemp McGraw Hall-1971.
2. Organic Photochemistry, 2nd Ed., J. Coxon, and B. Halton 2nd Edn .CambridgeUniversity press-1987.
3. Fundamentals of photochemistry, Rohtagi & Mukherjee Wiley Eastern-1992.
4. Advanced Organic Chemistry, Reactions, Mechanism and Structure, 4th Ed., Jerry March (Wiley, 1999).
5. Organic Chemistry, 5th Ed., John McMurry. (Brooks/Cole, 2000).
6. Organic Chemistry, J. Clayden, N. Greeves and S. Warren. Oxford University Press, 2nd Edition, 2016.
7. Pericyclic Reactions, Ian Fleming, Oxford University Press, 2nd Edition, 2015.
8. Essentials of Pericyclic and Photochemical Reactions, Biswanath Dinda, 1st Edition, 2016.

Third Semester
Core Course
Course Title: Electrochemistry and Solid State Chemistry
Course code: CHM603C

Credits = 4
M.M. = 100

Unit I: Electrochemistry-I

Ion-solvent Interactions: Non-Structural (Born) treatment and an introduction to structural (Ion-Dipole, Ion-Quadruple) treatments of ion-solvent interactions, Ion-Ion interactions: Activity and activity coefficients, Debye-Huckel theory of activity coefficients of electrolyte solutions; Derivation of Debye-Huckel limiting law, Validity and extension to high concentrations, Ion-pair formation- Bjerrum model, Debye-Huckel-Onsager conductance equation and brief idea of its extension.

Unit II: Electrochemistry-II

Metal-electrolyte electrified interfaces, Concept of surface excess, Thermodynamics of electrified interface, Lippmann equation, Electrocapillary curves, Methods for determination of surface excess. Structural models of metal-electrolyte interface: Helmholtz-Perrin, Gouy-Chapman and Stern models, Semiconductor electrodes: Structure of semiconductor/electrolyte interface, Theories of heterogeneous electron transfer: Electron transfer at electrified interface at and away from equilibrium, Butler-Volmer Equation, Low and high field approximations, Significance of transference-coefficient.

Unit III: Solid State Chemistry-I

Point groups, Space groups, Lattice Planes and Miller indices, Bragg equation, Debye-Scherrer method of X-ray structural analysis, Identification of cubic unit cells from systematic absences in diffraction pattern, Structure factor and its relation to intensity and electron density. Crystal structure of Perovskite (SrTiO_3) and Rutile (TiO_2).

Crystal defects and their types, Point defects: Schottky and Frenkel defects, Thermodynamics of Schottky and Frenkel defect formation, Colour centres, Dislocations and their types.

Unit IV: Solid State Chemistry-II

Band theory of solids

Semiconductors: Intrinsic and extrinsic semiconductor (n-type and p-type), Temperature dependence of charge carriers, p-n junction- devices based on p-n junction (tunnel diode, injection laser).

Super conductors: Characteristic properties- Zero resistance, Meissner effect, Heat capacity, Thermal conductivity, Absorption of electromagnetic radiations and Josephson effect. BCS theory of superconductivity, Applications.

Luminescence, Lasers: laser action, Solid state laser, Gas laser.

Liquid crystals and their applications.

Books Recommended:

1. Physical Chemistry - P. W. Atkins, Oxford, 2010.
2. Physical Electrochemistry-Fundamentals, Techniques and Applications, E. Gileadi, Wiley-VCH, 2011.
3. Electrochemistry, Carl H. Hamann, Andrew Hammett, Wolf Vielstich, Wiley-VCH. 2nd Edn.; 2007
4. An Introduction to Aqueous Electrolyte Solutions, Margaret Robson Wright, Wiley, 1st Edn.; 2007.
5. Modern Electrochemistry 1, 2A, J. O. Bokris and A. K. Reddy, Kluwer Academic/plenum Publishers, New York. 2nd Edn.; 2002,
6. Electrochemical methods, Fundamentals and Methods, A. J. Bard, L. R. Faulkner, Wiley, 2nd Edn.; 2002
7. Introduction to Solids, Azaroff, Tata McGraw, 1993.
8. Solid State Chemistry and its Applications, A R West, Wiley, 1989.
9. Solid State Physics, N.W.Ashcroft and N.D.Mermin, Saunders College, 2001.
10. Elements of Solid state Physics, J.P. Srivastava, Prentice Hall of India, 2003.

Third Semester
Core Course
Course Title: Chemical, Thermal and Electroanalytical Methods of Analysis
Course Code: CHM604C

Credits = 4
M.M. = 100

Unit I: Acid Base Titrations

Titration curves for strong acid- strong base, weak acid- strong base and weak base- strong acid titrations, Polyfunctional acids and bases. Determining the equivalence points, Theory of acid- base indicator, selection of proper indicator, indicator errors. Determination of nitrogen, sulphur, ammonium salts, nitrates and nitrites, carbonates and bicarbonates and other organic functional.

Titration curves for strong acid- strong base, weak acid- strong base and weak base- strong acid titrations, Polyfunctional acids and bases. Determining the equivalence points, Theory of acid- base indicator, selection of proper indicator, indicator errors. Determination of nitrogen, sulphur, ammonium salts, nitrates and nitrites, carbonates and bicarbonates and other organic functional.

Titration curves for strong acid- strong base, weak acid- strong base and weak base- strong acid titrations, Polyfunctional acids and bases. Determining the equivalence points, Theory of acid- base indicator, selection of proper indicator, indicator errors. Determination of nitrogen, sulphur, ammonium salts, nitrates and nitrites, carbonates and bicarbonates and other organic functional.

Unit II: Complexation Titrations

Introduction, Types of EDTA titration (Direct, back, replacement and other miscellaneous methods), Formation of complexes. Complexation equilibrium, Complexation Titration, stability of complexes, stepwise formation constants, chelating agents. Aminocarboxylic acid titrations, complexes with metal ions, equilibrium calculations involving EDTA, Factors affecting the shape of EDTA titration curves. Completeness of reactions, indicators for EDTA titrations, theory of common indicators.

Precipitation titrations: Titration curves feasibility of precipitation titrations. Factors affecting shape- titrant and analyte concentration. Completeness of the reaction. Titrants and standards. Indicators for precipitation titrations involving silver nitrate. Volhard, Mohr and Fajan's methods. Typical applications.

Unit III: Thermal Methods of Analysis

Introduction to thermal methods of analysis, Thermo gravimetric analysis (TGA), Apparatus, Methodology, Factors effecting TGA curve, Applications of TGA for quantitative analysis, thermal stability of materials, mixture analysis, Kinetic studies, (TG analysis of $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, problems based TGA)

Differential thermal analysis (DTA), Apparatus, Methodology, simultaneous DTA and TGA curves, Interpretation of TGA and DTA curves of compounds e.g., Calcium oxalate monohydrate, Magnesium oxalate monohydrate, Brief introduction to Thermometric titrimetric and applications to acid-base and complexometric titrations.

Unit IV: Electrochemical Methods

Voltametry and polarographic analysis: Principle of polarography, residual current, migration current, diffusion current, half wave potential, Ilkovic equation, instrumentation, Dropping mercury electrode (DME), Advantages and dis-advantages of DME, Qualitative and quantitative analysis of inorganic ions Cu, Bi, Pb, Cd, Zn, AC polarography, Pulse polarography Anode stripping voltametry: Principle, instrumentation, Hanging mercury drop electrode, Application in the analysis of Pb and Cd in environmental samples, Principle of cathode stripping voltametry

Books Recommended:

1. Principals of Physical chemistry, Puri, Sharma, Pathania, 4th edition 2016-17
2. Ionic Equilibria in Analytical Chemistry; Freiser and Fernando, 1966.
3. Introduction to chemical Analysis, R. D. Braun, Mc. Graw-Hill, International Book Co., 1983
4. Chemical Analysis, 2nd Ed., H.A. Laitinen and W.E. Harris, McGraw Hill Kogakusha, Ltd., 1975.
5. Instrumental Methods of Analysis, 7th Ed., Willard, Merritt, Dean and Settle, CBS Publishers, New Delhi.
6. Instrumental methods of Chemical Analysis, 5th edn., G.W. Ewig, McGraw Hill Book Co., 1985.
7. Instrumental Methods of Analysis by G.D. Christian and C.N. Reilly. 2nd Edn.; 1986.
8. Principle of Instrumental Methods of Analysis; D.A. Skoog, D.M. West and F.J. Holler, Sounders College Publishing New York, 2001.

Third Semester
Core Course
Course Title: Advanced Laboratory Course
Course Code: CHM605C

Credits = 4
M.M. = 100

Spectrophotometry

1. To study the complexation reaction between Fe (III) & salicylic acid.
2. Determine the dissociation constant of an indicator by spectrophotometric method.
3. Determination of Iron (II) with 1,10-Phenanthroline.
4. Determination of Phosphate by Molybdenum blue method.
5. Estimation of aspirin from given tablet by Spectrophotometry
6. Interpretation of IR spectrum of alcohols, ketones, aldehydes and other standard material

Potentiometry

7. Precipitation titration of KCl, KBr, KI and their mixture with AgNO_3
8. Determination of formation constant of Ag-NH_3 complex
9. Standardization of an Iron (II) solution with a standard dichromate solution over Pt & Calomel assembly.
10. Estimation of iodide with Standard AgNO_3 over Pt and Calomel assembly using I^-/I_2 redox couple.
11. Simultaneous determinations of chloride and iodide ions with Standard AgNO_3 over Ag-Glass electrode assembly

Conductometry

12. Verification of Debye-Huckel-Onsagar law.
13. Estimation of the concentrations of H_2SO_4 , CH_3COOH and CuSO_4 in a mixture.
14. To determine the solubility and solubility product of a sparingly soluble salt (BaSO_4) in water.
15. To determine the basicity of sodium potassium tartarate by conductometric method.

Kinetics

16. Study the kinetics of reaction between potassium persulphate and potassium iodide:
 - a) Determine the rate constant and order of reaction.
 - b) Study the influence of ionic strength on the rate constant.

Viscometry

17. Determination of Mol. Mass of a Polymer (Polyvinyl alcohol) using viscosity method.

Polarimetry

18. Determination of specific, molecular and intrinsic rotation of an optically active compound
19. Study of inversion of cane sugar in presence of acid.

pH-metric Titrations

20. Purity of Acetyl Salicylic acid (Aspirin) in a commercial tablet by pH Titration.
21. Quantitative analysis of chromate dichromate mixture by pH titration.

Flame Photometry

22. Simultaneous determination of sodium and potassium in a given mixture
23. Determination of cadmium and magnesium in tap water

Chromatography

24. Separation of some organic compounds by column chromatography
25. Analysis of Paracetamol from given unknown sample by HPLC
26. Separation of Cobalt (II) and Nickel (II) on anion exchange column followed by estimation through EDTA titrations.
27. Separation of two Cobalt (III) complexes viz $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$ and $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ on Silica column.

Synthetic Preparations

28. Preparation of tetraamminecarbonatocobalt (III) nitrate and its conversion to pentaamminechlorocobalt (III) chloride.
29. Preparation of trans dichloro bis (ethylenediamine), cobalt (III) chloride and its conversion to cis-isomer.
30. Reaction of Cr(III) with a multidentate ligand; a kinetic experiment (visible spectra Cr-EDTA complex)
31. Synthesis of aspirin and its characterization by physical and spectroscopic methods.
32. Synthesis of paracetamol and its characterization by physical and spectroscopic methods.
33. Beckmann rearrangement.

Extraction/Estimation of Organic compounds from natural sources

34. Isolation of lycopene and beta-carotene from tomato, Characterization of lycopene/P-carotene by UV -absorption process.
35. Isolation of caffeine from cold drinks and its physicochemical analysis.
36. Estimation of ascorbic acid in Vitamin C tablet by titration with potassium bromate
37. Estimation of phosphoric acid in soft drink by molybdenum blue method.
38. Estimation of BOD and DO in Waste Water Sample
39. Estimation of acid value of oil

Books Recommended:

1. Practical Physical Chemistry ----Findley revised by Kitchner.(Longman, 1971)
2. Experimental Physical Chemistry, A. M. Halpern, G. C. McBane, (Freeman, 2006)
3. Experiments in Physical Chemistry, 5th ed. ---- Schoemaker et al. (MGH, 2003)
4. Synthesis and Technique in Inorganic chemistry , G. S.Girlomi; R.J. Angleci 3rd edn.; University Science Books.
5. Synthesis and characterization of Inorganic compounds W.AJolly
- 6.Experimental Inorganic / Physical Chemistry ; Mounir A. Malati Horwood/1999.
7. Quantitative Chemical Analysis ; 5th edn.; Harris ; Freeman ; 1999.
8. Advanced Practical Inorganic Chemistry ; Adams ; Raynor, Wiley ; 1995.
9. Advanced Experimental Inorganic Chemistry ; Ayodha Singh ; Campus Books 2002.
10. Practical Clinical biochemistry methods and interpretations, R.Chawla, J.P. Bothers Medical Publishers (P) ltd., 1995.
11. Laboratory manual in biochemistry, J. Jayaraman, New Age International Publishers, New Delhi, 1981.
12. Practical clinical Biochemistry-Harold Varley and Arnold.Hein mann, 4th edn
13. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint.2003 Pearson Education Pvt. Ltd., New Delhi
14. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 Prentice Hall, Inc. New Delhi.
15. Quantitative Chemical Analysis; Kolthoff, sandell Meehan and Bruckestein; Mcmillan Co., London, 1969

Third Semester
Discipline Centric Course
Course Title: Spectroscopy of Organic Compounds
Course Code: CHM606E

Credits = 3
M.M = 100

Unit I: Ultraviolet and Infrared Spectroscopy

Introduction, Ultraviolet absorption spectra of dienes (homo and heteroannular), Enones, Carbonyl compounds, Unsaturated carbonyl compounds, Aromatic and heteroaromatic compounds, Effect of solvent on electronic transitions, Effect of conjugation on ultraviolet spectra, Woodward-Fieser rules, Applications and limitations, Kuhn's rule, Application to conjugated polyenes.

Introduction, Characteristic vibrational frequencies of alkanes, Alkenes, Alkynes, Alcohols, Ethers, Phenols, Amines, Aldehydes, Ketones, Acids, Anhydrides, Esters, Lactones, Amides and conjugated carbonyl compounds, Effect of hydrogen bonding and solvent on vibrational frequencies in IR spectra.

Unit II: Mass Spectrometry

Introduction, Instrumentation, A typical mass spectra, molecular ion peak, Ion production, EI, CI, FD, FAB, ESI and MS/MS methods, Role of isotopes in mass spectrometry, Fragmentation pattern of various classes of organic compounds, Metastable peak, Nitrogen rule, High resolution mass spectrometry. Fragmentation pattern, Initial ionization event, α -cleavage, Inductive cleavage, Two bond cleavage, Retro-Diels Alder cleavage and McLafferty rearrangement.

Unit III: Proton Nuclear magnetic resonance spectroscopy ($^1\text{H-NMR}$)

Shielding effect, 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 mercapto). Chemical exchange, Effect of deuteration, Complex spin-spin interactions between two three, four and five nuclei (first order spectra) virtual coupling, Stereochemistry. Simplification of complex spectra, Nuclear magnetic double resonance, Contact shift reagents, Solvent effect, Fourier transform technique, Nuclear overhauser effect (NOE). Bio-chemical applications of NMR (examples).

Unit IV: Carbon-13 NMR Spectroscopy

General considerations, Chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), Coupling constant, Two dimensional NMR spectroscopy (brief idea)- COSY, NOESY, DEPT, INEPT, APT and INADEQUATE techniques. Problems on structure elucidation based on the data from different spectroscopic techniques.

Books recommended:

1. Spectroscopy of Organic Compounds, P.S. Kalsi, New Age International Private Limited (1 January 2016).
2. Introduction to Spectroscopy. Donald L. Pavia, Gary M. Lampman, George S. Kriz, James A. Vyvyan. Cengage Learning, 2008.
3. Spectrometric identification of Organic Compounds. 5th Ed., R. M. Silverstein, G. C. Bassler and T. C. Morill. (Jhon Wiley-1991).
4. Introduction to NMR Spectroscopy, R. J. Abraham, J. Fisher and P. Loftus (Wiley- 1991)
5. Applications of absorption spectroscopy of Organic Compounds, J. R. Dyer (Prentice Hall-1991).
6. Spectroscopic Methods in organic Chemistry, D. H. Williams; I. Fleming (Tata- McGraw Hill-1988).

Third Semester
Discipline Centric Course
Course Title: Spectroscopy of Inorganic Compounds
Course Code: CHM607E

Credits = 3
M.M. = 100

Unit I: NMR Spectroscopy

Multinuclear NMR spectroscopy in inorganic chemistry. Paramagnetic shift in ^1H NMR spectra, ^{31}P NMR, ^{11}B NMR ^{19}F NMR (Splitting pattern and spectrum). Exchange process in solution Spin-spin coupling, Magnetic resonance imaging (MRI), MRI contrast agents, Brief introduction of solid-state NMR.

Unit II: Mossbauer Spectroscopy (MB Spectroscopy)

Technique of Mossbauer Spectroscopy, Gamma-ray fluorescence, Gamma radiation source, Doppler effect, Isomer shift, quadrupole splitting, Magnetic hyperfine splitting, Applications in inorganic complexes (Bonding and Structure of Fe^{2+} and Fe^{3+} compounds, Sn^{2+} and Sn^{4+} , Recognition of nature of M-L bond, Coordination compound, Structure and oxidation state.

Unit III: Electron Spin Resonance (ESR/EPR Spectroscopy)

Principle of ESR spectroscopy. Hyperfine structure in ESR spectra, Hydrogen atom, Methyl radical, $(\text{SO}_3)_2\text{NO}^-$ anion, Fermi-contact interaction, g -factor: g_{\parallel} and g_{\perp} . Applications of ESR, Spin labels, McConnell equation, Isotropic and anisotropic systems, Hyperfine splitting, Spin hamiltonian, Kramer's degeneracy and Zero field splitting. ESR Spectra of some transition metal complexes and biomolecules.

Unit IV: Nuclear Quadrupole spectroscopy (NQR)

NQR Isotopes, Basic theory of quadrupole spectroscopy, Quadrupole nuclei, Nuclear quadrupole moment, Electric field gradient (EFG), Nuclear Quadrupole Coupling constant, Effect of applied magnetic field (Zeeman effect), Towns-Dailey Theory, Applications of NQR and NQR spectra of $^{14}\text{N}_7$, $^{11}\text{B}_5$.

Books Recommended:

1. NMR, NQR and EPR and Mossbauer Spectroscopy in Inorganic Chemistry; Parish and Elis, H; 1990.
2. Nuclear Quadrupole Resonance Spectroscopy, Das, T. P. and Hahn, E. L. Academic Press; 1958.
3. Principles of Physical Chemistry; Pure, B. R. Sharma, L. R. and Pathiana, M. S; 47th Edition.
4. Spectroscopy in Inorganic Chemistry; Vol I and II; Rao, Ferraro; Academic Press; 1970.
5. Structural Methods in Inorganic Chemistry; 2nd edn; Ebsworth, E. A. V and Rankin, D. W. H; ELBS; 1991.
6. Inorganic Chemistry; Catherine, E. H and Sharpe, A. G; 2nd Edition, Pearson.

Third Semester
Discipline Centric Course
Course Title: Chemoinformatics
Course code: CHM608E

Credits = 3
M.M. = 100

Unit I: Representation of Molecules and Chemical Reactions

Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification.

Unit II: Searching Chemical Structure

Full structure search, sub structure search, basic ideas, similarity search, Three dimensional search methods, Basics of computation of physical and chemical data and structure descriptors, Data visualization.

Unit III: Computer Assisted Virtual Screening Design

Structure based virtual screening- Protein ligand docking, Scoring functions for protein ligand docking, Practical aspects of structure based virtual screening, Prediction of ADMET properties, 2 D and 3D data searching, Chemical databases, Role of computers in chemical research.

Unit IV: Application of Chem-informatics in Drug Design

Quantitative structure-property relations, Descriptor analysis, Computer assisted structure elucidations, Target identification and validation, Lead finding and optimization, Analysis of HTS data, Design of combinatorial libraries, Ligand and structure based drug design

Books Recommended:

1. Andrew R. Leach, Valerie J. Gillet, Cluwer, Introduction to Chem-informatics, Academic Publisher, Netherlands, 2003
2. Lisa B. English (Editor), Combinatorial Library Methods and Protocols, Humana Press Inc, Volume:201, 2002
3. Frank Jensen, Introduction to Computational Chemistry, Wiley Publisher, Second Edition, 2006

Semester-IV

Forth Semester
Core Course
Course Title: Advanced Inorganic Chemistry
Course Code: CHM651C

Credits = 4
M.M. = 100

Unit I: Symmetry Aspects of Molecular Vibrations

Construction of character tables for C_{4v} , D_{3h} , D_{3d} and T_d . Application of group theory to IR and Raman spectroscopy, Symmetry of IR and Raman active normal vibrational modes of AB_2 , AB_3 , AB_4 type molecules. Determining the symmetry types of the normal modes (Normal mode analyses of water molecule, carbonate ion and N_2F_2), Contribution of particular internal coordinates to normal modes, Symmetry selection rules for fundamental vibrational transitions (qualitative treatment), Use of symmetry considerations to determine the number of active infrared and Raman lines (example SF_4).

Unit II: Symmetry Aspects of Hybrid and Molecular Orbitals

Transformations properties of atomic orbitals. Hybrid orbitals for sigma bonds in trigonal planar (BCl_3), Tetrahedral (CH_4), Square planar $[PtCl_4]^{2-}$ and trigonal bipyramidal (PF_5), Hybridization scheme for pi bonding in trigonal planar (AB_3) and tetrahedral (AB_4) systems, Mathematical form of equivalent hybrid orbitals, Trigonal planar sp^2 equivalent hybrid orbitals in BCl_3 , Tetrahedral sp^3 equivalent hybrid orbitals in CH_4 , Molecular orbitals for sigma bonding in trigonal planar and tetrahedral systems.

Unit III: Atomic Absorption and Emission Spectroscopy

Atomic Absorption Spectroscopy: Principle of atomic absorption spectroscopy, Instrumentation and applications of atomic absorption spectroscopy, Sensitivity, detection limit and spectral interferences in atomic absorption spectroscopy.

Atomic Emission Spectroscopy and Flame Photometry

Principle of emission spectroscopy, source of excitation, instrumentation for AES, Flame emission spectroscopy, Qualitative and quantitative analysis, Limitations of Flame emission spectroscopy, Principle of plasma emission spectroscopy, inductively coupled plasma source, ICP-AES instrumentation, applications and comparison of ICP-AES with AAS.

Unit IV: Inorganic Polymers

Boron nitrides: Carboranes, Metallocarboranes and Fluorocarbons: Introduction, preparation, properties, structure, bonding and uses, Polymeric Sulfur and Sulfur nitrides: Preparation, properties, structure, bonding and uses. Polyphosphates: preparation, reactions, properties, structure, bonding and uses. Silicates: Classification, properties, structure and uses. Silicones: Preparation, reactions, properties, structure, bonding and uses.

Books Recommended:

1. Chemical Applications of Group Theory: by F.A. Cotton.
2. Group Theory and Symmetry in Chemistry: by Lowell H. Hall.
3. Symmetry, Orbitals and Spectra: by Milton Orchin and H.H. Jaffe.
4. Physical Methods in Chemistry: by R.S. Drago.
5. Molecular Spectroscopy: by G.M. Barrow, McGraw-Hill.
6. Introduction to chemical Analysis, R. D. Braun, Mc. Graw-Hill, International Book Co., 1988
7. Inorganic Polymers NJLRay; Academic Press; 1978.
8. Inorganic Polymers James. E. Mark, Harry Alcock & Roberta West; Prentice Hall.
9. Inorganic Polymers F.G-A-Stone & W. A. Graham; Academic Press.
10. Instrumental methods of Chemical Analysis, 5th edn., G.W. Ewig, McGraw Hill Book Co., 1985.
11. Instrumental Methods of Analysis by G.D. Christian and C.N. Reilly.
12. Basic Concepts of Analytical Chemistry, S. M. Khopkar, New Age International Publishers, 2nd Edition, 2005.
13. Analytical Chemistry, G. L. David Krupadanam, D Vijaya Prasad, K. Varaprasad Rao, K.
14. L. N. Reddy, C. Sudhakar, University Press(india) Limited, 2001.
15. Analytical Chemistry, H. Kaur, Pragati Prakashan, 2008

Fourth Semester
Core Course
Course Title: Advanced Organic Chemistry
Course Code: CHM652C

Credits = 4
M.M. = 100

Unit I: Retrosynthetic Analysis

An introduction to synthons and synthetic equivalents, The importance of order of events in organic synthesis, Functional group interconversions, The disconnection approach. One group, Two group and electrocyclic disconnections, Examples involving connections and rearrangements.

Protection of functional groups: Principle of protection of carbon-hydrogen bonds (in terminal alkynes and hydrogens of aldehydes), Carbon-carbon double bonds, Alcoholic hydroxyl groups, Amine groups, Carbonyl and carboxyl groups.

Unit II: Natural Products

Terpenoids: Isoprene rule, Classification, Nomenclature, General methods of structure determination, Stereochemistry and synthesis of α -Pinene, Menthol, Farnesol. Biosynthetic routes to mono and sesquiterpenoids. Essential oils, their chemical composition, Extraction, Methods of analysis.

Alkaloids and flavonoids: Introduction, classification, nomenclature and general methods of structure determination, biosynthesis of flavonoids. Medicinal applications of flavonoids and alkaloids.

Unit III: Medicinal Chemistry

Classification and sources of drugs, concept of lead compounds and lead modification, Analogues, Structure activity relationship (SAR): isosterism, bioisosterism, changing the size and shape, number of methylene groups in chain, degree of unsaturation, Effect of introduction of methyl groups, Halogens, Hydroxyl, Carbonyl, Thiols sulphides groups and introduction/removal of ring systems on pharmacological activity. Prodrugs and types of prodrugs.

Unit IV: Heterocyclic Chemistry

Nomenclature of heterocycles (Hantzsch-Widman nomenclature, Replacement nomenclature), Non-aromatic and aromatic heterocycles. Structure of five membered, six membered and bicyclic heteroatomic systems, Aromaticity of various heterocyclic systems, Resonance energies. Mesoionic systems. UV/Visible and NMR spectroscopy of heterocycles. Reactivity of aromatic heterocycles. Synthesis of aromatic heterocycles, Reaction types most frequently used in heterocyclic ring synthesis, Cyclisation, Cycloaddition, Electrocyclic processes in heterocyclic ring synthesis.

Books Recommended:

1. Heterocyclic Chemistry, 4th Ed., J.A.Joule and K. Mills (Black Well Science. 2000).
2. Medicinal Chemistry- An Introduction, Gareth Thomas (Wiley-2000). 3rd Edition.
3. Medicinal Chemistry, Ashutosh Kar. (Wiley Eastern-1993).
4. Organic Synthesis- concept, methods and Starting Materials, J. Furhop and G. Penzlin (Verlag VCH-1986).
5. Designing Organic Synthesis, S. Warren (Wiley-1978).
6. Some Modern Methods of Organic Synthesis, 3rd Ed., W. Carruthers (Cambridge University Press-1986).
7. Modern Synthesis Reactions, 2nd Ed. H.O. House (W.A.Benjamin, NY-1972).
8. Principles of Organic Synthesis 2nd, R.O.C.Norman (Chapman and Hall-1978).
9. Heterocyclic Chemistry, Thomas. L. Gilchrist, Prentice Hall; 3 Edition April 14, 1997.
10. Introduction to strategies for organic synthesis, Laurie S. Starkey, First Edition, John Wiley & Sons, 2018.

Forth Semester
Core Course
Course Title: Advanced Physical Chemistry
Course code: CHM653C

Credits = 4
M.M. = 100

Unit I: Quantum Chemistry-IV

Huckel's Pi-MO theory, Application to linear and cyclic polyenes, Aromaticity, Pi-electron charge and pi-bond-order. Alternant hydrocarbons, Naphthalene. Limitations of Huckel theory, Extended Huckel-method (basic idea). Self-Consistent field method: Hamiltonian and wave function for multi-electron systems, Electronic hamiltonian, Antisymmetrized wave function, Slater-determinant, Hartree-Fock self-consistent field method in the light of minimal basis H₂ molecule system ; one and two electron integrals. General polyelectronic system, Coulomb and exchange operators and integrals.

Unit II: Statistical Thermodynamics-II

Thermodynamic properties of a diatomic gas. Calculation of equilibrium constant using partition functions; examples of : isotope exchange reaction, H₂ + O₂ reaction, reaction between C₂H₄ and H₂. Concept of ensembles, ensemble average and postulate of equal a priori probability. Canonical, Grand-canonical and Micro-canonical ensembles. Perfect gas in canonical ensemble, Entropy and free energy. Grand partition function and its characteristic equation. Einstein model of energy and heat capacity of a solid using canonical partition function. Limitations of Einstein model, Debye model of heat capacity.

Unit III: Irreversible Thermodynamics

Basic principles of non-equilibrium thermodynamics: Second law of thermodynamics for open systems, law of conservation of mass, charge and energy. Irreversible processes and uncompensated heat, degree of advancement, reaction rate & affinity of a reaction. Relation of uncompensated heat to other thermodynamic functions. Entropy production, entropy production due to matter flow, heat flow, charge flow and chemical reactions; entropy production and efficiency of galvanic cells. Concept of forces and fluxes, Onsager's theory of irreversible processes, phenomenological laws, their domain of validity. Principle of microscopic reversibility and Onsager relations, Chemical reactions near equilibrium. Curie-Prigogine principle. Transformation properties of forces and fluxes.

Unit IV: Micelles, Solubilization and Micellar Catalysis

Surfactants: Classification , Kraft temperature and cloud point. Micellization : Critical micelle concentration (cmc), Aggregation number (N), Counterion binding. Factors affecting cmc and N in aqueous media, Structure and shape of micelles: Chain packing, Variation of micellar size and shape with surfactant concentration and organic additives. Thermodynamics of micellization: Pseudophase and mass action models. Mixed Micelle formation (two components): Clint equation, Rubing equation. Solubilization and factors affecting solubilization, Nature of surfactant/solubilize, Additive and temperature, Solubilization of drugs into micelles and its importance in drug delivery systems and controlled release. Micelles as reaction media: Theoretical consideration of reactions in micellar media, Examples of micellar catalysis for hydrolysis, Oxidation and reduction reactions.

Books Recommended:

1. Quantum Chemistry, D. A. McQuarie, Viva Books Pvt Ltd, Student edn.
2. Quantum Chemistry- Ira. N. Levine, Prentice Hall, 7th Edn.; 2013.
3. Quantum Chemistry, Prasad, New Age Publishers, 4th Edn.; 2010.
4. Norman, O, Smith, Elementary Statistical Thermodynamics, Plenum Press.
5. R.P.H. Gasser and W.G. Richards, Introduction of Statistical Thermodynamics, World Scientific, Singapore (1995).
6. D. A. McQuarie, Statistical Mechanics, Viva Books Pvt Ltd, Student edn
7. T.L. Hill, An Introduction to Statistical Thermodynamics, Dover, New York (1986).
8. Thermodynamics of Irreversible Processes; DeGroot, Mazur; Dover; 1986.
9. Introduction to Thermodynamics of Irreversible Processes; I. Prigogine; Wiley Interscience; 1967.
10. Thermodynamics for students of Chemistry, Kuriacose, Rajaram, (S. Chand and Co., 1996).
11. Modern Thermodynamics, D Kondipodi & I Prigogine, John Wiley & Sons, 2002
12. Robert J. Hunter, —Foundations of Colloid Science, Oxford University Press, New York, 2007.
13. P.C. Heimenz, —Principles of Colloid and Surface Chemistry, Marcel Dekker Inc. New York, 1986.
14. M. J. Rosen, —Surfactants and Interfacial Phenomena, John Wiley & Sons, New York, 2004.
15. D. Y. Meyer, —Surfaces, Interfaces and Colloid, VCH Publishers, Inc. 1991.

Fourth Semester
Core Course
Course Title: Polymers and Nanotechnology
Course code: CHM654C

Credits = 4
M.M. = 100

Unit I: Chemistry of Polymerization

Review and recapitulation (Importance of polymers, Basic concepts, Monomers, Repeat units, Degree of polymerization) Classification of polymers: skeletal structures, Isotactic polymers, Atactic polymers, Syndiotactic polymers, Graft polymers, Polymerization mechanism: Chain polymerization (Free radical, ionic, coordination), Step polymerization, Copolymerization, Miscellaneous polymerization reactions, Polymerization techniques (Bulk, Solution, Suspension, Emulsion polymerization), Polymer Reactivity, Engineering and specialty polymer; Polyamides, ABS, polycarbonates, Polysulphones.

Unit II: Polymer Characterization and Properties

Polydispersion and average molecular weight concept: Number, Weight and viscosity average molecular weights, Measurement of molecular weights: End-group, Membrane osmometry, light scattering and viscometry, Polymer crystallization, Morphology and chain tacticity; Melting (T_m) and glass transition (T_g) temperature, Effects of molecular weight, chemical structure, branching and cross linking on T_m and T_g , Relationship between T_m and T_g , Thermal analysis and Visco-elastic properties.

Unit III: Nanotechnology-I

Nanoscience and nanotechnology, Nanostructures in nature, Surface effects of nanomaterials, Surface plasmon resonance, Quantum size effects, Effect of size on properties; reactivity, optical, electrical, and magnetic properties. Application of nanomaterials in medicine, Nanomaterials for energy sector, Nanomaterials in food, Nanomaterials for the environment, Nanomaterials in automobiles.

Unit IV: Nanotechnology-II

Nanomaterials synthesis, Top-down and bottom-up approaches, Mechanical attrition (Ball Milling and Tube milling), Lithography, Co-precipitation, Sol-Gel Method. Solvothermal synthesis, Hydrothermal synthesis, Reverse micellar/Micro-emulsion method, Reverse micelles as nano reactors. Brief introduction to characterization techniques for Nano-materials

Books Recommended:

1. Textbook of Polymer Science, F.W. Billmeyer Jr., John Wiley & Sons, Inc., 2000.
2. An Introduction to Polymer Chemistry, W.R. Moore, University of London Press Ltd., London.
3. Introduction to Polymers, R.J. Young and P.A. Lovel, Chapman & Hall, London.
4. Polymer Chemistry-An Introduction, R.B.Seymour & C.E. Carraher, Jr., Marcel Dekker, Inc., New York.
5. Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Sreedahr, New Age International(P) Ltd. Publishers, 2001.
6. Sperling LH, *Introduction to Physical Polymer Science*, Fourth Edition, Wiley-Inter science (2005)
7. Chanda M, *Introduction to Polymer Science and Chemistry, A Problem Solving Approach*, CRS Press (2006)
8. Principals of Nanoscience and Nanotechnology, M. A. Shah and Tokeer Ahmad, Narosa Publications, 2010.
9. Nano Materials, B. Viswanathan, Narosa Publications, 2009.
10. Nano: The Essentials, T. Pradeep, Tata Mcgraw Hill, 2009.
11. Chemistry of Nanomaterials: Synthesis, Properties and Applications by C.N.R. Rao, A.Muller and A. K. Cheetham (eds.), Wiley-VCH, Weinheim, 2004.
12. Nanoscale Materials by Luis M. Liz-Marzan and Prashant V.Kamat, Kluwer Academi Publishers (Boston), 2003.
13. Physical Principles of Electron Microscopy: An introduction to TEM, SEM and AFM by R.F. Eqrton, Springer, 2008.

Forth Semester
Core Course
Course Title: Project and Dissertation
Course Code: CHM655C

Credits = 4
M.M. = 100

- In this course, the student will choose a lab oriented problem and perform theoretical and practical work after reviewing literature from different sources.
- The student will be guided by a faculty during this course and will have to submit a short synopsis, duly verified by the faculty, project coordinator and Head of the Department.
- The student will have to submit a dissertation based on the problem chosen by him/her (after consultation with the guide) during this course to the Department for evaluation.
- The student will also have to give a seminar about the literature surveyed and work done during this course.

Syllabus
for
(Open Elective Course)

Open elective courses offered by the Department of Chemistry for other Departments of the University.

Course Code	Course Title	Course Type	Maximum Marks			Credit Distribution			Credit	Total Credits
			Internal*	Final	Total	L	T	P		
CHM001	Biomolecules	Open Elective	25	25	50	2	0	0	2	2
CHM002	Nanoscience and Polymers	Open Elective	25	25	50	2	0	0	2	2
CHM051	Chemistry in Everyday Life	Open Elective	25	25	50	2	0	0	2	2
CHM052	Life and Contributions of Some Famous Scientists	Open Elective	25	25	50	2	0	0	2	2

*(Midterm 15 marks +Assignment 5 marks + Attendance 5 marks)

Open Elective Course
Course Title: Biomolecules
Course Code: CHM001

Credits = 2
M.M. = 50

Unit I: Organic Biomolecules

Carbohydrates: Classification (aldoses and ketoses), monosaccharide (glucose and fructose), oligosaccharides (sucrose, lactose, maltose), polysaccharides (starch, cellulose, glycogen), Importance of carbohydrates.

Proteins: Elementary idea of amino acids, polypeptides, proteins, Functions of proteins.

Vitamins: Classification and functions.

Unit II: Bio-inorganic Chemistry

Evidences regarding the presence of inorganic elements in biological systems, Biochemical role of calcium and magnesium, Biological role of Haemoglobin, Myoglobin and Vitamin B₁₂, Elementary idea of Nitrogen fixation.

Books Recommended:

1. Organic Chemistry by I. L. Finar Vol-II., ELBS Publications. 6th Edn.; 2002.
2. Bio-organic Chemistry J. Rohr, Springer, 2000.
3. Bio-organic Chemistry. A Chemical Approach to Enzyme Action, Herrmann Dugas Springer, 3rd Edn.; 1999.
4. Bio-inorganic Chemistry -An introduction; Ochai, Allyn and Bacon; Abbe books, 1977.
5. Inorganic Bio-chemistry, Eichhorn; —Vol. 1 & 2; Elsevier, 1973.
6. Inorganic Chemistry – Puri, Sharma and Kalia. Milestone publishers, 32nd Edn.; 2014
7. Introduction to Bioorganic Chemistry and Chemical Biology. D. V. Vranket and Gregory Weiss; Taylor and Francis. 1st Edn.; 2012.
8. Bio-inorganic Chemistry ; K. Hussain Reddy; New Age International (P) Ltd; 1st Edn.; 2009

Open Elective Course
Course Title: Nanoscience and Polymers
Course Code: CHM002

Credits =2

M.M. = 50

Unit I: Nanotechnology

Introduction to Nanoscience and Nanotechnology, Idea of size, Nanotechnology in Nature.
Properties of materials at nanoscale: Optical, electrical and magnetic properties.
Common application of Nanoscience in agriculture, medicine, water treatment and food packaging

Unit II: Polymers and their Applications

Introduction and classification of polymers, importance of polymers over other materials
Common uses of some polymers
Polyethylene
Polyvinyl chloride
Teflon
Rubber
Polyamide,
Polyacrylonitrile

Books Recommended:

1. Nanotechnology, J. Ramsden, Elsevier, 1st Edn.; 2011.
2. Nanotechnology Importance and Application, Fulekar, I K International Publishing House, 2010.
3. Springer Handbook of Nanotechnology, B. Bhushan (Editor), 3rd Edn.; 2010.
4. Essentials of Nanotechnology. J Ramsden, 2009.
5. Nanotechnology Fundamentals and Applications, Manasi Karkare, I K International Publishing House, 2008.
6. Introduction to Nanoscale Science and Technology, M. Ventra, S, Evoy, J.R. Heflin. Springer; 2004.

Open Elective Course
Course Title: Chemistry in Everyday Life
Course Code: CHM051

Credits =2

M.M. = 50

Unit I: Medicines and their Use

Chemicals in medicines: Introduction and classification of drugs: Analgesics, Tranquilizers, Antiseptics, Disinfectants, Antimicrobials, Antifertility drugs, Antibiotics, Antacids, Some lifesaving drugs: Epinephrine Hydrochloride (Adrenaline), Dexamethazone Sodium phosphate, Meperidine Hydrochloride (Pethidine), Diazepam, Aspirin, Drug addiction.

Unit II: Chemicals for Food Preservation

Preservatives: Need for preservatives, Classification and types, Natural preservatives.

Artificial sweetening agents: Classification, types and their effects, Common uses of sweetening agents.

Antioxidants: Classification and types, Natural antioxidants and applications.

Books Recommended:

1. DRUGS A Very Short Introduction; Oxford University Press; 2001
2. Pharmacology: An Introduction to Drugs; Michael C. Gerald; Prentice Hall; 1974
3. The Chemistry of Food; Jan Velisek; Willey Blackwell; 2014

Open Elective Course
Course Title: Life and Contributions of Some Famous Scientists
Course Code: CHM052

Credits =2

M.M. = 50

Unit I: Early Science and Scientists

Introduction to Science.

Life and works of Asclepius and Hippocrates, Hippocrates as an inspiration source of science.

Aristotle: Early life and contributions, Physics and metaphysics, Philosophy of Science.

Ptolemy, Avicenna and Jabir ibn Hayyan: Works and scientific contributions.

Copernicus and Galileo: Science of stars and telescopic discoveries.

Unit II: Life and Work of Modern Scientists

Life and works of Antoine Lavoisier, Humphry Davy, Michael Faraday, G. N. Lewis.

Life and works of Marie Curie, Rosalind Franklin, Fritz Haber, Svante Arrhenius, Linus Pauling.

Life and works of Isaac Newton, Albert Einstein, Abdus Salaam, Ahmed Zewail.

Life and works of some famous national scientists: C. V. Raman, S. N. Bose, Meghnad Saha, Srinivasa Ramanujan,

Rivalries and politics in Science.

Books Recommended:

1. The 100 Most Influential Scientists of All Time; Britannica Educational Publishing; 2010.
2. Great Physicists: The Life and Times of Leading Physicists from Galileo to Hawking ; William H. Cropper ;2004.
3. Humphry Davy: Science and Power, Cambridge University Press, Cambridge, David M. Knight; 2003.
4. Master Mind: The Rise and Fall of Fritz Haber, the Nobel Laureate Who Launched the Age of Chemical Warfare, Harper Collins, New York, Daniel Charles; 2005.
5. Journey into Light: Life and Science of C. V. Raman; Oxford University Press; G. Venkataraman.; 1989.
6. Nucleus and Nation: Scientists, International Networks, and Power in India. University of Chicago Press; Robert S. Anderson 2010.

SCHEME OF EXAMINATION

First Semester:

Subject	Assessment			
	Internal	Assignment+Attendance	External	Total
Metal-Complexes and Reaction Mechanism	30	20	50	100
Stereochemistry and Reaction Intermediates	30	20	50	100
Quantum Chemistry and Thermodynamics	30	20	50	100
Introduction to Spectroscopic Methods	30	20	50	100
Mathematics for Chemists	15	10	25	50
Green Chemistry	15	10	25	50
Practical and Viva-voce	Practical Performance	Practical Copy + Attendance	Viva-voce	Total
Lab Course in Physical Chemistry	50	20	30	100
Lab Course in Inorganic Chemistry	50	20	30	100

Second Semester:

Subject	Assessment			
	Internal	Assignment+Attendance	External	Total
Metal Clusters and Electronic Spectra of Metal Complexes	30	20	50	100
Mechanism of Organic Reactions	30	20	50	100
Quantum Chemistry, Kinetics and Statistical Thermodynamics	30	20	50	100
Chromatographic Techniques	30	20	50	100
Bioinorganic Chemistry	15	10	25	50
Conducting Polymers	15	10	25	50
Practical and Viva-voce	Practical Performance	Practical Copy + Attendance	Viva-voce	Total
Lab Course in Organic Chemistry	30	30	40	100
Lab Course in Analytical Chemistry	30	30	40	100

Third Semester:

Subject	Assessment			
	Internal	Assignment+Attendance	External	Total
Theory				
Organometallic chemistry	30	20	50	100
Pericyclic Reactions and Organic Photochemistry	30	20	50	100
Electrochemistry and Solid State Chemistry	30	20	50	100
Chemical, Thermal and Electroanalytical Methods of Analysis	30	20	50	100
Spectroscopy of organic compounds	30	20	50	100
Inorganic spectroscopy	30	20	50	100
Chemoinformatics	30	20	50	100
Practical and Viva-voce	Practical Performance	Practical Copy + Attendance	Viva-voce	Total
Advanced Laboratory Course	30	30	40	100

Fourth Semester:

Subject	Assessment			
	Internal	Assignment+Attendance	External	Total
Theory				
Advanced Inorganic Chemistry	30	20	50	100
Advanced Organic Chemistry	30	20	50	100
Advanced Physical Chemistry	30	20	50	100
Polymers and Nanotechnology	30	20	50	100
Project/Dissertation	Dissertation	Presentation	Viva-voce	Total
	50	25	25	100

EVALUATION CRITERIA

Examination criteria for the internal assessment of theory:

Name of Student	Registration No./ Roll No.	Continuous assessment and Attendance (20)	Mid-Term (30)	End-Term (50)	Total Marks (100)

Evaluation criteria for the internal assessment of practical:

Name of Student	Registration No./ Roll No.	Practical Performance (50)	Viva (30)	Practical Record (10)	Lab Attendance (10)	Total Marks (100)

LIST OF ADJUNCT FACULTY

S.No	Name of Faculty	Address	Specialization
1	Professor Gautam R. Desiraju	Solid State and Structural Chemistry Unit Indian Institute of Science Bangalore-560 012 Phone: +91 (0)80 2293 3311 E-mail: desiraju@sscu.iisc.ernet.in	Solid State and Structural Chemistry
2	Professor Absar Ahmad	Interdisciplinary Nanotechnology Center (INC), AMU, Aligarh Mobile: 9823064820 Email: director.inc@amu.ac.in	Nanotechnology
3	Professor Siddharth Pandey	Department of Chemistry Indian Institute of Technology, Hauz Khas New Delhi Mobile: +91 11 2659-1501 E-Mail: hod@chemistry.iitd.ac.in	Physical Chemistry
4	Professor M. Muneer	Department of Chemistry Aligarh Muslim university Sayeed Manzil, Wadi-E-Ismail, Near Masjid Ibrahim, Dhora Mafi, Aligarh - 202002 Mobile :+919897279787 Email : readermuneer@gmail.com m.muneer.ch@amu.ac.in	Organic Chemistry
5	Professor Khaliq uz Zaman	Department of Chemistry University of Kashmir Mobile: 9906540300 Email: khaliq.ku@gmail.com	Organic Chemistry
6	Professor Imran Ali	Department of Chemistry Aligarh Muslim university Nagina House, Adam Nagar Barauli Road Aligarh Mobile: 9536322688 Email: aneesahmad@yahoo.com	Applied Chemistry
7	Professor Anwar Ali	Department of Chemistry, Jamia Millia Islamia (Central University) New Delhi-110025 Mobile: 09540382691 Email: aali2@jmi.ac.in ; anwarali.chem@gmail.com	Physical Chemistry
8	Professor Altaf H. Pandith	Department of Chemistry University of Kashmir Mobile: 9906424293 Email: altafpandit23@gmail.com	Spectroscopy
10	Professor H.N. Sheikh	Department of Chemistry University of Jammu Email: hnsheikh@rediffmail.com ; hnsheikh@jammuuniversity.in Phone: 0191-2493124(R) 9419148792(Mob.)	Inorganic Chemistry
11	Professor D. I. Brahmhatt	Department Of Chemistry, Sardar Patel University, Vallabh Vidyanagar-388 120 Email: drdibrahmbhatt@gmail.com Phone: 9427547665	Organic Chemistry
12	Dr.Masood Ahmad Rizvi	Department of Chemistry University of Kashmir Mobile: 9419405757 E-mail: masood_ku2@yahoo.com	Inorganic Chemistry
13	Dr. Mohsin Ahmad Bhat	Department of Chemistry University of Kashmir Mobile: 9419033125 Email: mohsin_skb@yahoo.co.in	Physical Chemistry

CERTIFICATE FORMAT

**ISLAMIC UNIVERSITY
OF SCIENCE & TECHNOLOGY****DEPARTMENT OF CHEMISTRY****CERTIFICATE**

On the basis of declaration submitted by.....bearing Registration No.....of Department of Chemistry, I hereby certify that the dissertation titled “.....”submitted to the Department of Chemistry, School of Sciences, Islamic University of Science and Technology, Awantipora, J&K in partial fulfillment of the requirement for the award of the Master’s degree is an original contribution with existing knowledge and faithful record of project carried out by him/her under our guidance and supervision.

To the best of our knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place & Date:

Student

Supervisor

Head