UNIVERSITY OF RAJASTHAN

JAIPUR

SYLLABUS

M.SC. CHEMISTRY

Semester Scheme

I[st] Semester Exam December 2016

M. Sc. (Semester) CHEMISTRY Syllabus based on Credit System (2016-17 onwards)

FIRST SEMESTER

S. No.	Subject Code	Course Title	Course Category	Credit	Contact hours per week			EoSE Duration (hrs)	
					L	T	P	Th	Prct
1.	CHE 701	Advanced Inorganic Chemistry – I (Theories of Bonding, Spectroscopic methods & Nuclear Chemistry)	CCC	4	4	0	0	3	0
2.	CHE 702	Organic Reaction Mechanism	CCC	4	4	0	0	3	0
3.	CHE 703	Quantum, Surface and Electro-Chemistry	CCC	4	4	0	0	3	0
4.	CHE 711	Core Laboratory	CCC	6	0	0	9	0	9
5.	CHE A01	Spectroscopy –I	ECC	4	4	0	0	3	0
6.	CHE B01	Green and Sustainable Chemistry	ECC	4	4	0	0	3	0
7.	CHE C01	Analytical Techniques	ECC	4	4	0	0	3	0
8.	CHE D01	(a) Mathematics / (b) Biology for Chemistry	ECC	4	4	0	0	3	0
9.	CHE D11	Elective Laboratory-I	ECC	6	0	0	9	0	9

SECOND SEMESTER

S. No.	Subject Code	Course Title	Course Category	Credit	Contact hours per week			EoSE Duration (hrs)	
					L	T	P	Th	Prct
1.	CHE 801	Advanced Inorganic Chemistry– II (Group Theory, Molecular rearrangement processes & Reactivity Mechanisms)	CCC	4	4	0	0	3	0
2.	CHE 802	Stereochemistry, Photochemical and Pericyclic Reactions & Rearrangements	CCC	4	4	0	0	3	0
3.	CHE 803	Thermodynamics and Chemical Kinetics	CCC	4	4	0	0	3	0
4.	CHE 811	Core Laboratory	CCC	6	0	0	9	0	9
5.	CHE B02	Biomolecules	ECC	4	4	0	0	3	0
6.	CHE D02	Spectroscopy – II	ECC	4	4	0	0	3	0
7.	CHE D03	Environmental Chemistry	ECC	4	4	0	0	3	0
8.	CHE D12	Elective Laboratory-I	ECC	6	0	0	9	0	9

THIRD SEMESTER

S. No.	Subject Code	Course Title	Course Category	Credit	Contact hours per week			EoSE Duration (hrs)	
					L	T	P	Th	Prct
1.	CHE 901	Organotransition Metal Chemistry	CCC	4	4	0	0	3	0
2.	CHE 902	Organic Synthesis – I	CCC	4	4	0	0	3	0
3.	CHE 903	Electrochemistry	CCC	4	4	0	0	3	0
4.	CHE 911	Core Laboratory	CCC	6	0	0	9	0	9
5.	CHE A02	Advanced Bioinorganic Chemistry	ECC	4	4	0	0	3	0
6.	CHE A03	Supramolecular Chemistry	ECC	4	4	0	0	3	0
7.	CHE A04	Inorganic Polymers	ECC	4	4	0	0	3	0
8.	CHE B03	Heterocyclic Chemistry – I	ECC	4	4	0	0	3	0
9.	CHE B04	Natural Product – I	ECC	4	4	0	0	3	0
10.	CHE B05	Medicinal Chemistry	ECC	4	4	0	0	3	0
11.	CHE C02	Bio-Physical Chemistry	ECC	4	4	0	0	3	0
12.	CHE C03	Advanced Chemical Kinetics	ECC	4	4	0	0	3	0
13.	CHE C04	Advanced Electrochemistry and Analytical Techniques	ECC	4	4	0	0	3	0
14.	CHE A11	Elective Laboratory-1	ECC	6	0	0	9	0	9
15.	CHE B11	Elective Laboratory-2	ECC	6	0	0	9	0	9
16.	CHE C11	Elective Laboratory-3	ECC	6	0	0	9	0	9

FOURTH SEMESTER

S. No.	Subject Code	Course Title	Course Category	Credit	Contact hours per week			EoSE Duration (hrs)	
					L	T	P	Th	Prct
1.	CHE X01	Solid States and Nanomaterials	CCC	4	4	0	0	3	0
2.	CHE X02	Organic Synthesis – II	CCC	4	4	0	0	3	0
3.	CHE X03	Advanced Physical Chemistry (Spectroscopy and Macromolecules)	CCC	4	4	0	0	3	0
4.	CHE X11	Core Laboratory	CCC	6	0	0	9	0	9
5.	CHE A05	Materials and Industrial Chemistry	ECC	4	4	0	0	3	0
6.	CHE A06	Photoinorganic Chemistry	ECC	4	4	0	0	3	0
7.	CHE B06	Heterocyclic Chemistry – II	ECC	4	4	0	0	3	0
8.	CHE B07	Natural Product – II	ECC	4	4	0	0	3	0
10.	CHE C05	Advanced Nano Science and Technology	ECC	4	4	0	0	3	0
11.	CHE C06	Chemical Analysis	ECC	4	4	0	0	3	0
12.	CHE A12	Elective Laboratory-1	ECC	6	0	0	9	0	9
13.	CHE B12	Elective Laboratory-2	ECC	6	0	0	9	0	9
14.	CHE C12	Elective Laboratory-3	ECC	6	0	0	9	0	9

सचिव

Core Subject 12 Compulsory Theory (each 4 Credit / 4hrs) + 4 Compulsory Laboratory (each 6 Credit/ 9 hrs). Elective Theory (each 4 Credit/4 hrs) + Elective Labs (each 6 Credit each / 9 hrs)

Elective Papers

A: Inorganic Specialization
B: Organic Specialization
C: Physical Specialization
D: Allied / Integrated Chemistry

S. No.	Elective Course Code	Course Title	Course Category	Semester
1.	CHE A01	Spectroscopy –I	ECC	I
2.	CHE A02	Advanced Bioinorganic Chemistry	ECC	III
3.	CHE A03	Supramolecular Chemistry	ECC	III
4.	CHE A04	Inorganic Polymers	ECC	III
5.	CHE A05	Materials and Industrial Chemistry	ECC	IV
6.	CHE A06	Photoinorganic Chemistry	ECC	IV
7.	CHE B01	Green and Sustainable Chemistry	ECC	I
8.	CHE B02	Biomolecules	ECC	II
9.	CHE B03	Heterocyclic Chemistry – I	ECC	III
10.	CHE B04	Natural Product – I	ECC	III
11.	CHE B05	Medicinal Chemistry	ECC	III
12.	CHE B06	Heterocyclic Chemistry – II	ECC	IV
13.	CHE B07	Natural Product – II	ECC	IV
14.	CHE C01	Analytical Techniques	ECC	I
15.	CHE C02	Bio-Physical Chemistry	ECC	III
16.	CHE C03	Advanced Chemical Kinetics	ECC	III
17.	CHE C04	Advanced Electrochemistry and Analytical Techniques	ECC	III
18.	CHE C05	Advanced Nano Science and Technology	ECC	IV
19.	CHE C06	Chemical Analysis	ECC	IV
20.	CHE D01	(a) Mathematics / (b) Biology for Chemistry	ECC	I
21.	CHE D02	Spectroscopy – II	ECC	II
22.	CHE D03	Environmental Chemistry	ECC	II
23.	CHE D11	Elective laboratory-1 (Inorganic + Organic + Physical)	ECC	I
24.	CHE D12	Elective laboratory-2 (Inorganic + Organic + Physical)	ECC	II
25.	CHE A11	Elective laboratory-3 (Inorganic)	ECC	III
26.	CHE B11	Elective laboratory-4 (Organic)	ECC	III
27.	CHE C11	Elective laboratory-5 (Physical)	ECC	III
28.	CHE A12	Elective laboratory-6 (Inorganic)	ECC	IV
29.	CHE B12	Elective laboratory-7 (Organic)	ECC	IV
30.	CHE C12	Elective laboratory-8 (Physical)	ECC	IV

उप सचिव

SEMESTER – I

CHE 701: ADVANCED INORGANIC CHEMISTRY – I
(Theories of Bonding, Spectroscopic methods and Nuclear Chemistry)

4 Credit (4 hrs/week)

Theory and Tutorial: 4 hours per week (4 credits)
Examination: Theory Paper - 3 Hours; Max. Marks- 100

Note: **1.** Candidate has to attempt five questions in all. All questions carry equal marks.
2. Question no. 1 covering whole syllabus will consist of 10 short answer questions carrying 2 marks each.
3. Question No. 2 to 5, each of 20 marks, will be framed by taking one question from each unit. There will be an internal choice within the unit.

UNIT - I

A. Stereochemistry and Bonding in Main Group Compounds:

Limitations of VSEPR Theory, $d\pi$-$p\pi$ bond, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules

B. Metal Ligand bonding:

Limitation of crystal field theory, molecular orbital theory, and introduction to ligand field theory: σ-bonding in octahedral and tetrahedral complexes, π-bonding and molecular orbital theory.

UNIT - II

Electronic Spectra of Transition Metal Complexes

Spectroscopic ground states, correlation diagrams, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), calculations of Dq, Racah parameters (B) and nephelauxetic ratio (β) parameters, charge transfer spectra.

UNIT - III

Optical Rotatory Dispersion (ORD)-Circular Dichroism (CD) and Magnetic Properties of Transition Metal Complexes

Spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical conformation, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

UNIT – IV

Nuclear and Radiochemistry:

Laws of radioactive decay; Detection of radiations; Geiger-Nuttal rule; GM tubes and their characteristics; Ionization chamber, Proportional counters, Scintillation counters; Solid state detectors; Calibration of counting equipments; Determination of absolute disintegration rates.

Activation analysis: Principles; Various methods of activation; Methodology; Advantages, limitations and applications.

SUGGESTED BOOKS AND REFERENCES

1. Inorganic Chemistry, Principles of structure and Reactivity, 4th Edition; James E. Huheey: Elleu A. Keiter: Richard L. Keiter.
2. Advanced Inorganic Chemistry; F.A. Cotton and G. Wilkinson.
3. Theoretical Inorganic Chemistry; Day and Selbin.
4. Concepts and Models in Inorganic Chemistry; Doughlas Mc Daniel.
5. Physical Methods in Inorganic Chemistry; R. S. Drago.
6. Chemistry of the Elements; N.N. Greenwood and A. Earnshow, Pergamon, 1984.
7. Inorganic Electronic Spectroscopy; A.B.P. Lever, Elsevier, 1968.
8. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and J.A. Mc Cleverty, Pregamon, 1987; Vol. 2.

9. Nuclear and Radiochemistry; G. Friedlander, J. W. Kennedy, E. S. Macias and J. M. Miller; 3rd Edn., Wiley: NY, 1981.
10. Essentials of Nuclear Chemistry, H. J. Arnikar; 4th Eds., New Age International: N Delhi, India, 2011.
11. Nuclear and Radiochemistry: Fundamental and Applications, 2 Vols., Jens-Volker Kratz and Karl Heinrich Lieser; 3rd Edn., John Wiley & Sons: UK, 2013.

CHE 702: ORGANIC REACTION MECHNAISM

4 Credit (4 hrs/week)

Theory and Tutorial: 4 hours per week (4 credits)
Examination: Theory Paper - 3 Hours; Max. Marks- 100
Note: **1.** Candidate has to attempt five questions in all. All questions carry equal marks.
2. Question no. 1 covering whole syllabus will consist of 10 short answer questions carrying 2 marks each.
3. Question No. 2 to 5, each of 20 marks, will be framed by taking one question from each unit. There will be an internal choice within the unit.

UNIT- I

Reaction Mechanism: Structure and Reactivity

A review of types of mechanisms and reactions, methods of determining reaction mechanism, thermodynamic and kinetic requirements for reaction, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett Principle, Isotope effects. Effects of structure on reactivity, resonance and field effects, steric effects. Quantitative treatment of the effect of structure on reactivity. The Hammett equation and linear free energy relationship, substituent and reaction constants, Taft equation.

Aromaticity: Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons. Huckel's rule, energy level of π-molecular orbitals, annulenes, anti-aromaticity, homo-aromaticity, PMO approach, energetic and magnetic concept.

UNIT - II

Aliphatic Nucleophilic Substitution

The S_N1, S_N2, mixed S_N1-S_N2 and SET mechanisms. The S_Ni mechanism. The neighbouring group mechanism - neighbouring group participation by π and σ bonds, anchimeric assistance. Classical and nonclassical carbocations, phenonium ions, norbornyl system. Application of NMR spectroscopy in the detection of carbocations. Nucleophilic substitution at the allylic, aliphatic trigonal and a vinylic carbon.

Reactivity - effect of substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophile, regioselectivity.

Aromatic Nucleophilic Substitution

The S_NAr, S_N1, benzyne and $S_{RN}1$ mechanisms. Reactivity - effect of substrate structure, leaving group and attacking nucleophile. The von Richte, Sommelet-Hauser and Smiles rearrangements.

UNIT - III

Aliphatic Electrophilic Substitution

Bimolecular mechanisms - S_E2 and S_Ei. The S_E1 mechanism - electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and solvent polarity on reactivity.

Aromatic Electrophilic Substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagrams.The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction.

Free Radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity of aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic

halogenations (NBS). Oxidation of aldehydes to carboxylic acids, auto- oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

UNIT - IV

Addition to Carbon-Carbon Multiple Bonds

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

Addition to Carbon-Heteroatom Multiple Bonds

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Mechanism and application of condensation reactions involving enolates - Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions.

Elimination Reactions

The E2, El and ElcB mechanisms. Steric orientation of the double bond. Reactivity, effect of substrate structure, the attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic eliminations.

SUGGESTED BOOKS AND REFERENCES

1. Advanced Organic Chemistry: Reactions Mechanisms and Structure by Jerry March, McGraw Hill.
2. Mechanism and Structure in Organic Chemistry – E. S. Gould (Holt, Rinehart and Winston).
3. Advanced Organic Chemistry Part-A. F.A. Carey and R.J. Sundberg, 5th Ed. Springer (2007).
4. Physical Organic Chemistry – J. Hine.
5. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes. Longman
6. Organic Chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers. Oxford University Press (2001)
7. Structure and Mechanism in Organic Chemistry. C.K. Ingold. Cornell University Press.
8. Organic Chemistry. R.T. Morrison and R N. Boyd. Prentice-Hall.
9. Modern Organic Reactions. H O House, Benjamin.
10. Principles of Organic Synthesis. R O C Norman and J.M. Coxon. Blackie Academic & Professional.
11. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.

CHE 703: QUANTUM, SURFACE AND ELECTROCHEMISTRY

4 Credit (4 hrs//week)

Theory and Tutorial: 4 hours per week (4 credits)
Examination: Theory Paper - 3 Hours; Max. Marks- 100

Note: 1. Candidate has to attempt five questions in all. All questions carry equal marks.
2. Question no. 1 covering whole syllabus will consist of 10 short answer questions carrying 2 marks each.
3. Question No. 2 to 5, each of 20 marks, will be framed by taking one question from each unit. There will be an internal choice within the unit.

UNIT - I

Fundamental Quantum Mechanics

Historical background of Quantum Mechanics; Black body radiation: De Broglie equation: Postulates of Quantum mechanics; Operators: Linear, Nonlinear Operator, Postulates of Quantum mechanics; Eigen functions and eigen values of an operator; Time dependent and time independent Schrodinger equation

Quantum mechanics of transitional and vibrational motions

Particle in 1D box with infinite potential walls; free particle in 1D box, tunneling effect; particle in 3D box, 1D harmonic oscillator; Harmite equation and Harmite polynomials; recursion relation, wave functions and wave enregies; harmonic oscillator model and molecular vibrations

Quantum mechanics of Rotational motion
Co-ordinate systems Cartesian, cylindrical polar and spherical polar co-ordinates and their relationship;
Quantum mechanics of Hydrogen like atoms

UNIT - II

Angular Momentum
Ordinary angular momentum, generalized angular momentum, eigen functions for angular momentum, eigen values of angular momentum, operator using ladder operators, addition of angular momenta, spin, antisymmetry and Pauli exclusion principle.
Approximate Methods
The variation theorem, linear variation principle, Perturbation theory (First order and nondegenerate) Applications of variation method and perturbation theory to Helium atom.
Molecular Orbital theory
Huckel theory of conjugated. systems, bond order and charge density Calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene, benzene. Introduction' to extended Huckel theory

UNIT - III

Surface Chemistry
A. Adsorption
Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electro-kinetic phenomenon)
B. Micelles
Surface active agents, classification of surface active agents, micellization, hydrophobic interaction , critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization -phase separation and mass action models, solubilization, micro emulsion, reverse micelles.

UNIT - IV

Electrochemistry
Electrochemistry of solutions, Debye-Huckel-Onsager treatment and its extension, ion solvent interactions. Debye-Huckel-Jerum mode. Thermodynamics of electrified interface equations. Derivation of electro capillarity, Lippmann equations (surface excess), methods of determination. Structure of electrified interfaces, Guoy-Chapman, Stern, Graham Devanatham-Mottwatts, Tobin, Bockris, Devanathan models, Over potentials, exchange, current density, derivation of Butler Volmer equation, Tatel plot. Polarography theory, Ilkovic equation; half wave potential and its significance.

SUGGESTED BOOKS AND REFERENCES

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Introduction to quantum Chemistry, A.K. Chandra, Tata McGrawHill.
3. Quantum Chemistry. Ira N. Levine, Prentice Hall.
4. Quantum Chemistry; R.K. Prasad, new age international
5. Micelles, Theortical and Applied aspects; V. Morai, Plenum Press.
6. Modern Electrochemistry Vol. I & II; J.O. M. Bockris and A.K.N. Reddy Plenum Press. New York.
7. Physical chemistry by Puri, Sharma and Pathania Vishal Publications.

CHE 711: CHEMISTRY CORE LAB

6 Credit (9 hrs/week)

A. Qualitative analysis of mixture consisting of eight radicals (cationic / anionic forms) including:
   a. Interfering anionic radical
   b. Insolubles: oxides, sulphates and halides
   c. Less common metal ions: Ti, Mo, Tl, W, Zr, Ce, Th, V, U

B. Separation, purification and identification of components of Organic binary mixture [(one liquid and one solid) or (two solids)].

C. **I. Surface tension**
   a. To study surface tension concentration relationship for solution (Gibbs equation).

b. To determine the critical micelle constant of soap by surface tension techniques.

II. Viscosity

a. Determine the viscosity of a liquid by Ostwald's viscometer.

III. Adsorption

a. Adsorption of Oxalic acid

b. Acetic acid on charcoal

CHE A01: SPECTROSCOPY – I

4 Credit (4 hrs/week)

Theory and Tutorial: 4 hours per week (4 credits)
Examination: Theory Paper - 3 Hours; Max. Marks- 100

Note: 1. Candidate has to attempt five questions in all. All questions carry equal marks.
2. Question no. 1 covering whole syllabus will consist of 10 short answer questions carrying 2 marks each.
3. Question No. 2 to 5, each of 20 marks, will be framed by taking one question from each unit. There will be an internal choice within the unit.

UNIT - I

Introduction: Interaction of light with matter, mechanism of absorption and emission of radiation.

Microwave Spectroscopy:

Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor; stark effect, nuclear and electron spin interaction and effect of external field applications.

Vibrational Spectroscopy:

Vibrational energies of diatomic molecules, zero point energy, force constant and bond strengths; anharmonicity, Morse potential energy diagram, vibration-rotation spectroscopy. P.Q.R. branches, breakdown of Oppenheimer approximation; vibrations of polyatomic molecules; selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intensities, far IR region, metal ligand vibrations.

Raman Spectroscopy:

Origin, rotational and vibrational Raman Spectra of diatomic molecules.

UNIT - II

Electronic Spectroscopy

Atomic Spectroscopy:

Energies of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogen atom and alkali metal atoms.

Molecular Spectroscopy:

Energy levels, molecular orbitals, vibronic transitions, vibrational progressions and geometry of the excited states, Franck-Condon principle, electronic spectra of polyatomic molecules. Emission spectra; radiative and non-radiative decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra.

Photoelectron Spectroscopy:

Photo-electric effect, ionization process, Koopman's theorem, photoelectron spectra of simple molecules, ESCA, chemical information from ESCA; Auger electron spectroscopy-basic idea.

UNIT-III

Magnetic Resonance Spectroscopy

Nuclear Magnetic Resonance:

Basic Principle : Spin quantum number, interaction between Spin and a Magnetic Field, Larmor Precession, Relaxation Times; Continuous Wave NMR Spectroscopy, Fourier Transform NMR Spectroscopy; Introduction to Chemical Shift, Spin-spin coupling, Coupling Constant; Nuclei other than hydrogen: Nuclei With Spin ½ (^{13}C, ^{19}F, ^{31}P, ^{117}Sn, ^{119}Sn, etc.), Nuclei With Spin Greater than ½

(^{14}N, ^{11}B). Quadrupole Effects; Factors effecting Chemical shift in inorganic compounds - geometry, electronegativity, charge, oxidation state, coordination number. Coupling between two or more than two types of NMR active nucleus in a compound (e.g. $CHFCl_2$, HPFCl, HOP(O)FH, $HP(O)F_2$, BH_4).

Electron Spin Resonance:

Basic principles, zero field splitting and Kramer's degeneracy, Isotropic and anisotropic Hyperfine coupling, spin-orbit coupling and significance of g-tensors, factors affecting the 'g' value, application to transition metal complexes; spin Hamiltonian, spin densities and McConnell relationship, applications - spin polarization for atoms and transition metal ions.

UNIT-IV

Mossbauer Spectroscopy:

Basic principles, spectral parameters and spectrum display, applications of the techniques to the studies of (i) bonding and structures of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin; (ii) Sn^{2+} and Sn^{4+} compounds, nature of M-L bond, coordination number, structure; and (iii) detection of oxidation state and in equivalent MB atoms.

Electron Microscopy:

Basic principles of Electron Microscopy: SEM, TEM, AFM; and their applications in structural analysis.

SUGGESTED BOOKS AND REFERENCES

1. Fundamentals of Molecular Spectroscopy, Banewell and McCash
2. Modern Spectroscopy, J.M. Hollas, John Wiley.
3. Applied Electron Spectroscopy for Chemical Analysis D. H. Windawi and F.L. Ho, Wiley Interscience.
4. Physical Methods in Chemistry, R.S. Drago, Saunders College.
5. Chemical Applications of Group Theory, F.A. Cotton.
6. Introduction to Molecular Spectroscopy, G.M. Barrow, Mc Graw Hill.
7. Electronic Absorption Spectroscopy and related Techniques, D N Sathyanarayana
8. Basic Principles of Spectroscopy, R. Chang, Mc Graw Hill.
9. Theory and Application of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBH-Oxford.
10. Introduction to Photoelectron Spectroscopy, P.K. Ghosh, John Wiley.
11. Introduction to Magnetic Resonance. A Carrington and A.D. Maclachalan, Harper & Row.
12. NMR Spectroscopy in Inorganic Chemistry, J. A. Iggo, Oxford University Press: Oxford, 1999, pp 1-21; 31-35.
13. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.

CHE B01:GREEN AND SUSTAINABLE CHEMISTRY

4 Credit (4 hrs/week)

Theory and Tutorial: 4 hours per week (4 credits)
Examination: Theory Paper - 3 Hours; Max. Marks- 100

Note: 1. Candidate has to attempt five questions in all. All questions carry equal marks.
2. Question no. 1 covering whole syllabus will consist of 10 short answer questions carrying 2 marks each.
3. Question No. 2 to 5, each of 20 marks, will be framed by taking one question from each unit. There will be an internal choice within the unit.

UNIT – I

Introduction, Principle and Concepts of Green Chemistry

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

UNIT – II

Non-traditional greener alternative approaches

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Different approaches to green synthesis: (a) Uses of green reagents in organic synthesis - Dimethyl carbonate, polymer supported reagents - per acids and chromic acid; (b) Green catalysts, role of catalysis in sustainable development, homogeneous and heterogeneous catalysts; Introduction, advantages and applications of - (i) Nanocatalysts, (ii) Phase transfer catalysts, (iii) Biocatalysts, (iv) Organocatalysts, in organic synthesis.

UNIT – III

Applications of non-conventional energy sources

Introduction of microwave induced synthesis: Microwave activation- equipment, time and energy benefits, limitations; Organic transformations under microwaves - Fries rearrangement, Diels-Alder reaction, decarboxylation, saponification of ester, alkylation of reactive methylene compounds; Heterocyclic synthesis- β-Lactams, pyrrole, quinoline.

Introduction of ultrasound assisted green synthesis: Instrumentation, physical aspects, applications in organic transformations.

Electrochemical synthesis: Introduction, synthesis of sebacic acid and adiponitrile.

UNIT – IV

Environmentally Benign Solutions to Organic Solvents

Ionic liquids as green solvents: Introduction, properties and types of ionic liquids. Synthetic applications - Diels-Alder reaction, epoxidation and Heck reaction.

Aqueous phase reactions: Enhancement of selectivity, efficiency. Synthetic applications - 1,3-Dipolar Cycloadditions, Carbon-Carbon bond-forming processes and bromination reactions.

Fluorous solvents in green chemistry: Scope, definition and their synthetic applicability.

Role of supercritical carbon dioxide in green chemistry.

Ethyl lactate as a renewable green solvent: Properties and applications.

SUGGESTED BOOKS AND REFERENCES:

1. P. A. G. Blackie, Organic synthesis in water, Springer.
2. P. T. Anastas, J. C. Warner, Green Chemistry, theory and practice, Oxford University Press.
3. M. Lancaster, Green Chemistry: An introductory text, Royal Society of Chemistry.
4. V. Polshettiwar, T. Asefa, G. Hutchings, Nanocatalysis: Synthesis and applications, Wiley.
5. M.A. Ryan, M. Tinnesand, Introduction to Green Chemistry, American Chemical Society.
6. P.T. Anastas, Handbook of Green Chemistry, John Wiley and Sons.
7. V. K. Ahluwalia, M. Kidwai, New Trends in Green Chemistry, Springer.

CHE C01: ANALYTICAL TECHNIQUES

4 Credit (4 hrs/week)

Theory and Tutorial: 4 hours per week (4 credits)
Examination: Theory Paper - 3 Hours; Max. Marks- 100

Note: **1.** Candidate has to attempt five questions in all. All questions carry equal marks.
2. Question no. 1 covering whole syllabus will consist of 10 short answer questions carrying 2 marks each.
3. Question No. 2 to 5, each of 20 marks, will be framed by taking one question from each unit. There will be an internal choice within the unit.

UNIT I

Statistics – Introduction to Chemometrics

Limitations of analytical methods, Errors and classification, Determinant, constant and indeterminate, accuracy, precision, minimization of errors, significant figures and computation rules, mean and standard deviation, distribution of random errors, variance and confidence interval, paired *t*-test, least square method, correlation and regression, linear regression.

UNIT II

Sampling in analysis

Definition, theory, basis and techniques of sampling, sampling statistics, sampling and physical state, crushing and grinding, hazards in sampling, techniques of sampling of gases, fluid, solids, and particulates, minimization of variables, transmission and storage of samples, high pressure ashing techniques (HPAT), particulate matter, its separation in gas stream, filtering and gravity separation, analysis of particulate matter like asbestos, mica, dust and aerosols etc.

Solvent extraction method in analysis

Principle, classification, theory, instrumentation and applications.

UNIT III

Conductometry:

Important laws, definitions, relations, effect of dilution on conductivity, measurement of conductivity, types of conductometric titrations, its applications and limitations.

Potentiometry:

Principle, instrumentation, types of potentiometric titrations and its applications, pH measurements, determination of pH, ion selective electrodes, instrumentation and applications.

UNIT IV

Coulometry:

Introductions, principle, experimental details of coulometry at constant current and constant potential, titrational applications.

Atomic Absorption Spectroscopy:

Introduction, principle, Grotrian diagram, instrumentation, applications, detection limit, sensitivity and disadvantages.

SUGGESTED BOOKS AND REFERENCES

1. Mendham J., Denney R.C., Barnes J. D., Thomas M. J. K., Vogels' text book of quantitative chemical analysis, 6th edition, Prentice Hall, 2000.
2. Skoog Douglas A., Holler F. James, Nieman Timothy A., Principles of instrumental analysis, Saunders College Pub., 1998.
3. Day R. A and A. L. Underwood, Quantitative analysis, Prentice Hall, 1999.
4. Drago R. S., Physical methods in Chemistry, Saunders, 1999.
5. Peters D.G, J. M. Hayes and G. M. Hefige, A brief introduction to Modern chemical analysis, Philadelphia: Saunders, 1976.
6. Ebsworth E.A.V, DWA Rankin and C. Craddock, Structural methods in inorganic chemistry, ELBS.
7. Elan JAD Butter Worth, Photoelectron spectroscopy.
8. Eliel E.L, Stereochemistry of carbon compounds, Tata-McGraw-Hill

CHE D01 (a): MATHEMATICS FOR CHEMISTRY

(For students without Mathematics in B.Sc.)

4 Credit (4 hrs/week)

Theory and Tutorial: 4 hours per week (4 credits)

Examination: Theory Paper - 3 Hours; Max. Marks- 100

Note: 1. Candidate has to attempt five questions in all. All questions carry equal marks.

2. Question no. 1 covering whole syllabus will consist of 10 short answer questions carrying 2 marks each.

3. Question No. 2 to 5, each of 20 marks, will be framed by taking one question from each unit. There will be an internal choice within the unit.

UNIT - I

Matrix Algebra

Addition and multiplication; inverse, adjoint and transpose of matrices, special matrices (Symmetric Skew-symmetric, Hermitian, skew-Hermitian, unit, diagonal, unitary etc.) and their properties. Matrix equations: Homogenous, non Homogenous, linear equations and conditions for the solution, linear

dependence and independence. Introduction to vector spaces, matrix eigen values and eigenvectors, diagonalization, determinants (examples from Huckel theory)

UNIT - II

Differential calculus

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

UNIT -III

Integral calculus, basic rules for integration, integration by parts, partial fraction and substitution. Reduction formulae, applications of Integral calculus.

Functions of several variables, partial differentiation, co-ordinate transformations (e.g. Cartesian to spherical polar).

UNIT - IV

Elementary Differential equations and Vectors

(a) **Elementary Differential equations:** First-order and first degree differential equations, homogenous exact and linear equations. Applications to chemical kinetics, secular equilibria, quantum chemistry etc. second order differential equations and their solutions.

(b) **Vectors:** Vectors, dot, cross and triple products etc. gradient, divergence and curl. Vector calculus.

SUGGESTED BOOKS AND REFERENCES

1. The Chemistry Mathematics Book, E. Steiner, Oxford University Press.
2. Mathematics for Chemistry, Doggett and Suicliffe, Longman.
3. Mathematical Preparation for Physical Chemistry, F. Daniels, McGraw Hill.
4. Chemical Mathematics, D.M. Hirest, Longman.
5. Applied Mathematics for Physical Chemistry, J.R. Barante, Prentice Hall.
6. Basic Mathematics for Chemist, Tebbutt, Wiley.

CHE D01 (b): BIOLOGY FOR CHEMISTS

(For students without Biology in B.Sc.)

4 Credit (4 hrs/week)

Theory and Tutorial: 4 hours per week (4 credits)

Examination: Theory Paper - 3 Hours; Max. Marks- 100

Note: **1.** Candidate has to attempt five questions in all. All questions carry equal marks.

2. Question no. 1 covering whole syllabus will consist of 10 short answer questions carrying 2 marks each.

3. Question No. 2 to 5, each of 20 marks, will be framed by taking one question from each unit. There will be an internal choice within the unit.

UNIT -I

Cell Structure and Functions

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

UNIT -II

Carbohydrates

Conformation of monosaccharides, structure and functions of important derivatives of monosaccharides like glycosides, deoxysugars, myoinositol, amino sugars.N-acetylmuramic acidsialic acid disaccharides and polysaccharides Structural polysaccharides-cellulose and chitin. Storage polysaccharides-starch and glycogen, Structure and functions of glucosaminoglycans or mucopolysaccharides, Carbohydrates of glycoproteins and glycolipids. Role of sugars in biological

recognition. Blood group substances, Ascorbic acid. Carbohydrates metabolism- Krebs cycle, glycolysis, glucogenesis and glycogenolysis, gluconeogenesis, pentose phosphate pathway.

UNIT -III

Lipids

Fatty acids, essential fatty acids, structure and functions of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Liproproteins- composition and function, role in atherosclerosis. Propertis of Lipids aggregates-micelles,bilayers liposomes and their possible biological functions. Biological membranes.Fluid mosaic model of membrane structure.

Lipid metabolism ~ β-oxidation of fatty acids.

UNIT -IV

Proteins and Nucleic acid

Structure of proteins-α-helix, β-sheets, super secondary structure. Triple helix structure of collagen. Tertiary structure of Protein-folding and domain structure. Quaternary structure of proteins

Nucleic Acids

Purine and pyrimidine bases of nucleic acids, base pairing via hydrogen bonding. Structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA), double helix model of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis for heredity, an overview of replication of DNA, transcription, translation and genetic code, chemical synthesis of mono and tri nucleosides.

SUGGESTED BOOKS AND REFERENCES

1. Principles of Biochemistry, A.L.Lehninger, Worth Publishers.
2. Biochemistry, L. Stryer, W.H. Freeman.
3. Biochemistry, J. David Rawan, Neil Peterson.
4. Biochemistry, Voet and Voet, John Wiley.
5. Outlines of Biochemistry, E.E. Conn and P.K. Stumpf, John Wiley.

CHE D11: ELECTIVE LAB-1

6 Credits (9 hrs/week)

Ex. 1 Laboratory Estimations

i. Estimation of an acid using another standard acid.
ii. Estimation of a base using another standard base.
iii. Determination of percentage purity of caustic soda.
iv. Determination of percentage purity of commercial soda.

Ex. 2 Green Chemistry Experiments

i. Clay catalyzed solid state synthesis of 7-hydroxy-4-methylcoumarin (Pechmann condensation)
ii. Preparation of 1, 1-bis-2-naphthol from β-naphthol
iii. Synthesis of adipic acid from cyclohexanol

Ex. 3 (a) Conductometry

i. Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by sodium hydroxide conductometerically.
ii. Determination of the strength of strong and weak acids in a given mixture conductometrically.

(b) Potentiometry/ pH metry

Determination of the strength of strong and week acids in a given mixture potentiometer/ pH-meter.